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Growth and Morphogenesis

Edmund W. Sinnott, *Yale University*

AN INDICATION of the great and continuing interest in the problems of organic development is the appearance of two volumes[1] of papers in this field. Those in the first volume were presented at a symposium of the Society for Experimental Biology held at Cambridge, England in July, 1947, and are now published under the title *Growth in relation to differentiation and morphogenesis.* Those in the second are an outgrowth of a conference on "The Chemistry and Physiology of Growth" held at Princeton in September, 1946, as part of the celebration of the Bicentennial of Princeton University.

These essays cover many of the fields of research in plant and animal development. They illustrate how the various disciplines of the life sciences are coming to focus on the central problem of the methods by which living matter produces those specifically formed and functioning structures which are so well termed organisms. Embryology, moving from its descriptive and phylogenetic beginnings to experimental attack, long ago began to study this question. Morphology, realizing that organic form is the visible expression of organization, began to seek the causes of form. Genetics, having outgrown its "classical" phase, is now engaged in the far more difficult problems of the mechanism of gene action and the relations between genes and the individuals which develop under their control. Physiology itself is concerned more and more with developmental problems. Various aspects of these fields are treated in the present volumes.

In the Cambridge symposium, the first paper, "The Role of the Cell in Determination" as illustrated by the metamorphosis of a blood-sucking bug, *Rhodnius,* is discussed by V. B. Wigglesworth, who suggests that "the supracellular fabric is a chemical continuum, a 'molecule' in the sense that it is held together by chemical bonds; and that it is the continuity of this substance from cell to cell which provides for the unity of the organism." It should be noted in passing that G. A. Baitsell presented this viewpoint in 1938 (*Amer. Nat.* 1940, **74**, 5–24).

[1] *Growth in relation to differentiation and morphogenesis.* (Symposia of the Society for Experimental Biology, No. II.) New York: Academic Press, 1948. Pp. vi + 365. (Illustrated.) $7.50.

The chemistry and physiology of growth. Arthur K. Parpart. (Ed.) Princeton, N. J.: Princeton Univ. Press, 1949. Pp. vii + 293. (Illustrated.) $4.50.

The next three papers are in the familiar tradition of experimental embryology and morphology. "Concepts on the Mechanism of Embryonic Induction and their Relation to Parthenogenesis and Malignancy," by J. Holtfreter, treats of embryonic induction in amphibia. The author believes that "the external stimuli capable of inducing these phenomena are unspecific and are related to each other merely by the faculty of causing the liberation and mutation of certain morphogenetic compounds (plasmagenes) which are self-reproductive." "On the Developmental Physiology of the Sea Urchin," by S. Hörstadius and T. Gustafson, discusses certain aspects of embryonic metabolism. In "Growth and Differentiation of Nerve Fibres" J. Z. Young describes the various processes concerned in the regeneration of nerves. Although we are beginning to gain some exact information about this process, the author thinks it unlikely that our knowledge of it will be quickly reduced to simple general terms.

These are followed by three papers in a related group dealing with factors concerned in the induction of flowering in the higher plants, especially photoperiodism, vernalization, temperature, and hormones. F. G. Gregory discusses "The Control of Flowering in Plants," presenting an excellent review of the various hypotheses which have been put forward; K. C. Hamner, "Factors Governing the Induction and Development of Reproductive Structures in Plants," with especial reference to "phasic development"; and R. Harder, "Vegetative and Reproductive Development of *Kalanchoë Blossfeldiana* as Influenced by Photoperiodism." With these should also be mentioned a paper which comes somewhat later in the volume, "Morphogenic Factors as Exemplified by the Onion Plant," by O. V. S. Heath and M. Holdsworth, which postulates two hormone systems controlling the formation of bulbs and of flowers.

P. J. Gaillard describes the culture *in vitro* of endocrine glands of man, especially the parathyroid, and their transplantation into patients suffering from glandular deficiency, with resulting success in effecting cures.

Five papers are concerned with one phase or another of the problem of gene action. C. H. Waddington in "The Genetic Control of Development" discusses various ways in which specific cytoplasmic

proteins, essential for the origin of differentiation, may be produced. In "Nucleus and Cytoplasm in Differentiation" K. Mather treats of the same problem from a somewhat different viewpoint. S. Spiegelman, in "Differentiation as the Controlled Production of Unique Enzymatic Patterns," supports the plasmagene theory on evidence derived from a study of enzymatic adaptation and enzyme patterns in general. Hans Grüneberg in "Genes and Pathological Development in Mammals" considers a wide range of gene effects which result in pathological or atypical characters. Ernst Hadorn describes "Gene Action in Growth and Differentiation of Lethal Mutants of Drosophila."

In quite a different vein are four papers which are concerned primarily with the development and the arrangement of leaves on the plant axis. F. J. Richards in "The Geometry of Phyllotaxis and its Origin," reviews the complex phenomena of phyllotaxis and considers various explanations which have been proposed for it. Mary Snow and R. Snow, writing "On the Determination of Leaves," consider the same problem on the basis of their experimental studies. Evidence from extensive experiments on the shoot tip is presented by Ernest Ball in "Differentiation in the Primary Shoots of *Lupinus albus* L. and *Tropaeolum majus* L.," especially with reference to histological differentiation. C. W. Wardlaw in "Experimental Morphology with Special Reference to Pteriodophytes" shows that in these plants, where the terminal meristem is dominated by an apical cell, the resulting growth pattern is essentially like that of the seed plants, where the meristem is very differently organized.

Plants with roots growing from their tips as an illustration of the use of plant hormones in modifiying growth and development. Early work was done by P. W. Zimmerman and A. E. Hitchcock of the Boyce Thompson Institute for Plant Research, Inc., Yonkers, New York. (*Science Service Photo.*)

The final essay, "Observations on the Present State of Embryology," by J. H. Woodger, is a plea for more attention to the construction of hypotheses in embryology, using the logical techniques now available. These hypotheses, which he thinks will probably seem very unorthodox, should be based not only upon biochemistry and X-ray crystallography, but upon the data of embryology itself, with the emphasis upon relational properties.

The Princeton volume contains ten essays, of which the first six are primarily concerned with growth rather than development. J. H. Northrop presents a general discussion of "Enzymes and the Synthesis of Proteins," with an extensive bibliography. F. O. Schmitt, in "Molecular Morphology and Growth," describes our knowledge of the fibrous proteins, and offers some suggestions for fruitful fields of study in connection with protein molecules generally. K. V. Thimann, in "Plant Growth Hormones," reviews the multiple effects of auxin on growth, especially with isolated plant parts. K. Folkers, in "Unidentified Vitamins and Growth Factors," describes a considerable series of these and their properties. C. B. van Niel, in "The Kinetics of Growth of Microorganisms," points out that with modern techniques for turbidity measurement growth studies on populations of such organisms can be readily made, and the kinetic aspects of growth analyzed. E. S. G. Barron, in "Cellular Metabolism and Growth." shows the relation between metabolic processes and the growth and division of cells.

The last four pages are of more particular interest to students of development and morphogenesis. Paul Weiss here treats at some length the problem of "Dif-

ferential Growth." He discusses cellular differentiation primarily in molecular terms, emphasizing molecular "ecology" and the importance of organization at cell surfaces. Growth, and especially its orientation and the elaboration of growth patterns, must be referred, he believes, to cellular differentiation, although behind it all, and not reducible to molecular terms, there is still a prior topographical organization to be reckoned with. There is no single master clue, he believes, to differential growth or to growth in general.

J. S. Nicholas discusses various "Problems of Organization," including nucleo-cytoplasmic relations, egg constituents, organizational dependencies, independent movements, mass movements, chemical organization, and regeneration, as illustrated in the embryology of amphibia, Drosophila, and the chick.

C. P. Rhoads approaches the problem of development through a study of "Neoplastic Abnormal Growth." He stresses especially the importance of genetic changes in the production of cancer, although self-perpetuating cytoplasmic factors and virus bodies cannot be neglected. "The neoplastic process," he believes, "is a distinctive, characteristic sort of abnormal growth, malignant as well as autonomous, something more than a quantitative deviation from the normal rate and extent of differentiation."

In "The Adrenal Gland, a Regulatory Factor," C. N. H. Long discusses the regulatory interplay of three elements of the endocrine system—anterior pituitary, adrenal cortex and medulla—and pays particular attention to the role of adrenal cortical hormones in hastening the translocation of intact cellular protein molecules to all parts of the body.

The variety of topics discussed in these volumes testifies to the wide diversity of viewpoints from which the problems of morphogenesis are being attacked and raises the question as to whether this field of biology does indeed have a content of subject matter and a program of specific objectives sufficiently different from other fields so that one is justified in treating it as a distinct discipline. Is it simply one kind of morphology, or physiology, or genetics, or is it different enough from all the rest to stand on its own feet?

The answer to our question, I think, is given in the very name morphogenesis itself—*the origin of form*. Perhaps the most distinctive aspect of living things is that they possess specific forms, those constant patterns of external and internal structure by which they can be recognized. What makes this fact significant is that form is the outward and visible expression of biological organization. Needham has well said that "the problem of organization is the central problem of biology, and the riddle of form is the fundamental riddle." Morphology deals with form, but in a descriptive and comparative manner only. So do its related disciplines of histology and anatomy. Embryology is concerned with the development of form but not its cause. Unlike these, morphogenesis endeavors to understand the mechanisms involved in form development and the fundamental causes which are responsible for it, thus striking at the heart of the problem of organization itself. Other biological sciences deal with other aspects of organisms—with their metabolism, their heredity, their evolution, their environmental relations or their classification—but only morphogenesis is concerned specifically with the problem of their organization, of what really makes them *organisms*. Morphogenesis as distinguished by its objectives thus occupies a unique position, and in a sense the topmost one, in the hierarchy of biology and seems clearly to deserve recognition as a distinct discipline.

If this is true, why should morphogenesis in practice often seem so diffuse, so fumbling? The answer is not difficult. It has, to be sure, a definite and unique goal, but this goal is one of extraordinary difficulty, since in a real sense it is the problem of life itself. It involves not only techniques of analysis, in which science is so completely at home, but the much more difficult ones of synthesis. It is concerned not only with specific substances, but more particularly with specific *relations*. The problem of organization, as the history of biology shows, is extraordinarily resistant to central attack. We can make forays into one corner of it or another, but to strike successfully at the citadel itself is so difficult that it may require tools and techniques which as yet we do not possess. It is no wonder that the morphogeneticist, circling around the periphery of his great objective, is often at a loss how to make a direct approach to it, and that his efforts frequently seem halting and ineffectual. What distinguishes a biologist when he is working in this field is not his methods, but the character of his objective.

What can the morphogeneticist do toward the solution of his problem? The volumes here under review show some of the lines of attack open to him. Much of a purely descriptive character, like Dr. Richards' analysis of phyllotaxy, yet remains to be done. In the minds of many, unfortunately, such work often suffers from the fact that it does not deal directly with causes, that it is not primarily experimental, that its conclusions do not seem to strike at the root of the matter. And yet such work is absolutely necessary to an understanding of the problems that are to be attacked, and often provides important clues for further progress. Certainly the concept of allometry, which has made it possible to express by single con-

stants the relative growth of parts or dimensions, has simplified many of the complex phenomena of development and has made it possible to present to the physiologist a much more concrete problem than would have been possible before the use of this new technique. D'Arcy Thompson's demonstration that one organic form may be transformed into another by the regular deformation of a coordinate system in which it has been inscribed, and that any modification of this form affects the whole system rather than a local part of it, is surely not without significance for an understanding of the integrating factors in development. The student of morphogenesis in his haste to use the methods of his colleagues in physiology and biochemistry should not neglect this descriptive part of his problem, for it may well point the direction in which he must guide his steps.

Of course the morphogeneticist also employs the techniques and draws upon the data of other fields of biology, as well as of biochemistry and biophysics, and most of the progress which he has made has come in this way. An analysis of the amphibian organizer is clearly one important line of attack. So is the study of how photoperiodism, temperature, mechanical factors, and phytohormones affect the development of plant structures. No analysis of development can be complete unless it considers the role of enzymes, nucleoproteins, and other factors which are primarily biochemical in their nature. Molecular morphology and ecology must be considered. The fine structure of protoplasm cannot be neglected, nor the evidence now available from electron microscopy. Certainly without an understanding of gene action no sound theory of morphogenesis can be built. These methods of attack and many others are open to the morphogenetic practitioner and it is here that most of his efforts at present are being exerted. Their wide diversity is what sometimes lays him open to criticism as a man who cannot make up his mind as to where he is going. He knows where he would like to go, but it is extraordinarily difficult to discover the way thither.

Temptations often beset anyone who undertakes to work in morphogenesis, temptations to oversimplify his problems, to regard as a solution something that is only a first step toward it. He is inclined, for example, to look for "formative substances" which by themselves control the development of specific structures. Many specific substances are certainly important in developmental processes and their study has done much to increase our knowledge of the mechanism of growth control. But it is naive, I think, to believe that any substance, however potent, can *of itself* determine a particular organic form. We should remember the words of J. S. Haldane, that "we are faced with the question how this particular substance is present at the right time and place, and reacts to the right amount to fulfil its normal functions." The substance is merely the agent of something more fundamental, of that "prior topographic organization" of which Dr. Weiss speaks. In the same vein, Dr. Woodger in his essay calls attention to the fact that many biochemical reactions take place quite differently inside a living organism from what they do *in vitro*. We should recognize that such substances do their work not directly, but by their effects on a system of organized relations through which the ultimate control is exercised. To stop anywhere short of an understanding of such a system is to fail in the ultimate aim of morphogenesis, however valuable and necessary any preliminary steps may be.

Of course to gain such understanding is remarkably difficult. Relations seem to be much harder things to study than atoms, but we should not hesitate to explore the problem as well as we can. The idea that Dr. Wigglesworth proposes, for example, that the whole organism is a chemical continuum and thus comparable, perhaps, to a single molecule, is such an exploratory attempt, and poses a problem which can be attacked. The possible relation between the form of protein molecules and that of the organism in which they occur may well be a fruitful idea. The whole concept of morphogenetic "fields," vague as it is, is a step in the same direction. The problem we are here facing is one of the ultimates. It may well require for its solution something more than the well-established concepts with which biology has chiefly dealt. Here is the place for those new, adventurous, and unorthodox hypotheses for which Dr. Woodger pleads, hypotheses which are not vague and hazy but which can be tested by techniques now available to biologists.

The present volumes are a challenge to all students of development, for they not only present the results of some very significant work in this field, but raise again the question of what morphogenesis is and ought to be, and point to the great enigma with which every student of biology is ultimately faced and which it is useless to evade or minimize—the problem of biological organization, which is really the problem of life itself.

A Cultural Approach to World Order

Kirtley F. Mather, *Harvard University*

ALTHOUGH "WORLD ORDER" necessarily involves "world government," it is increasingly apparent that the spirit of world community is even more essential to its attainment than any blueprint of legal structure or any document embodying a world constitution. Every intelligent person is now aware of the unity of the world from a functional and geographic viewpoint. Economic isolation is a thing of the past. But from the human viewpoint ours is a world of fragments. The segments of mankind are separated by cultural and ideological chasms that are wide and deep. There can be no "world order" until men emerge from their ethnocentric bomb shelters and participate in a common cultural development toward one world of humanity.

Dr. Northrop's symposium, *Ideological differences and world order*,[1] cuts therefore to the very heart of our present, most imperative problem. Its subtitle, *Studies in the philosophy and science of the world's cultures*, sounds erudite and academic, but it is in fact one of the most practical and pertinent approaches toward meeting the world's most poignant needs that anyone could undertake. It is still true, as Thomas Huxley said long ago, that "the world in which we live is governed by ideas." To become well acquainted with the ideas that rule the lives of men—ourselves and our fellows beyond the boundary lines on maps—is the first step toward the establishment of order in our world, and indeed there is no other step that can start us along that much desired pathway.

This book is uniquely valuable not only because of its purpose but also because of the method selected to accomplish that purpose. It is concerned essentially with "the ideological differences which present obstacles on the way" to the goal of world order and with "the methods suggested by the contemporary social sciences and the philosophy of culture for the removal of these obstacles." Its authors are many rather than one. Each of them "is indigenous to or expertly acquainted with the culture upon which he writes." The 21 essays comprising the volume are superficially independent of each other and quite individualistic in style and content. But they are integrated by the common objective and together they present a gratifyingly broad and fundamentally profound analysis of the world picture. It is not an altogether happy picture, but it depicts a reality that must be accepted and that has encouraging aspects as well as discouraging ones.

First in the sequence is Dean Roscoe Pound's contribution to the symposium on "The University and Its World Responsibilities" that was part of the Princeton University Bicentennial Celebration in 1947. Published here for the first time, it stresses the idea that "men with very different conceptions of the social order, groups of men with one ideal or picture of what ought to be and other groups with wholly divergent pictures, must live together and work together in a complex social organization." Without pretending "that education . . . is the one thing needful toward a world moral and legal order," he outlines convincingly the steps that universities might take to lay a foundation for a "new *jus gentium*."

The philosophy at the basis of traditional Chinese society is expertly presented by Professor Fung Yu-Lan, of Tsing Hua University, and the philosophical basis of Chinese painting is set forth in an unusually interesting and informative essay by Chiang Yee, artist and poet now residing in Oxford, England, who formerly was an administrative official in China and who for a time was a member of the faculty of the University of London.

Professor Emeritus Charles M. Bakewell, of Yale, former State Senator and U. S. Congressman, contributes the fourth essay, an analysis of the philosophical roots of western culture, and Matila Ghyka, formerly in the diplomatic service of Rumania and now visiting professor of esthetics in the University of Virginia, discusses the Pythagorean and Platonic scientific criterion of the beautiful in classical western art. Neither of these papers is as remote and academic as its title might suggest; even a geologist gained much significant information from them.

Continuing this routine of focusing the spotlight temporarily and sequentially upon various portions of the total scene, Professor Robert Grinnell, of the University of California, writes about Franciscan philosophy and Gothic art, and Dr. Overton H. Taylor, of Harvard, presents a penetrating study of the philosophies and economic theories in modern occidental culture. Professor Leopoldo Zea, of the National University of Mexico, follows with an analysis of positivism and Porfirism in Latin America.

[1] *Ideological differences and world order: studies in the philosophy and science of the world's culture.* F. S. C. Northrop. (Ed.) New Haven, Conn.: Yale Univ. Press. 1949. Pp. xi + 486. $4.50.

It is frequently stated that Soviet law has introduced conceptions which create an impediment to relations between the Anglo-American world and the USSR. Soviet jurists are equally sharp in their denunciations of the concepts of the common law of England and the United States. Professor John N. Hazard, of Columbia, therefore explores the charges and counter-charges and searches for the basic assumptions on which they appear to rest. Presumably with no ulterior motive for such juxtaposition, the next essay discusses the New Deal as a cultural phenomenon. It is by Professor T. V. Smith, now at Syracuse University, who concludes that "from defects as from virtues, one must nevertheless interpret the New Deal's course as America's penchant for the middle of the road."

Turning from regional to universal matters for a few moments, the book continues with an incisive, penetrating and illuminating essay by Professor P. W. Bridgman, of Harvard, Nobel Laureate in Physics, who explores the nature and the possibilities of the potential intelligent society of the future. "Never in human history has intelligence been allowed full opportunity, nor have its potentialities for a revolutionary recasting of society and culture been adequately appreciated." With his characteristically conservative optimism, Professor Bridgman believes that techniques are now in hand for making the necessary adjustments between the other emotional needs and the quest for truth, to which the first and foremost consideration must be given.

Next comes a most informative account of the philosophy of the British Labor Government by Lord Lindsay of Birker, Master of Balliol College at Oxford. In England as in America, the great unsolved problem "is whether planning is compatible with democratic freedom." The British Labor party does not yet know whether unemployment can be prevented and a high standard of living can be maintained without "a degree of compulsion entirely incompatible with [its] ideals and traditions." Across the channel the French are confronted by similar dilemmas. Professor Henri Peyre, of Yale, approaches them from the viewpoint of literature and philosophy in contemporary France.

American scientists will be especially interested in the next essay, dealing as it does with the impact of politics on science. Professor Manuel Sandoval Vallarta, of the National University of Mexico, was for a time the chairman of the United Nations Atomic Energy Commission, and in this essay he presents a cogent analysis of the conflict between ideas of security and secrecy that are natural components of the political and military mentality on the one hand and the necessity for freedom in research and communication that is recognized with equal naturalness in scientific circles on the other hand. His citation of the successful operation of the Mexican "Comisión Impulsora y Coordinadora de la Investigación Científica" since its establishment in 1943 is especially pertinent at this time when the 81st Congress is considering a National Science Foundation for the United States.

Scientists also will read with profit Julian Huxley's article about the purpose and philosophy of Unesco. It is a considerably abbreviated and slightly amended version of a pamphlet published in 1946. Since then he has become convinced that "Unesco can best achieve its aims by undertaking a program of concrete and limited projects, and that on such a program a remarkable degree of agreement can be reached among delegates with astonishingly different philosophical, racial, and cultural backgrounds." Even so, "Unesco needs not only a set of general aims and objects for itself but also a working philosophy, a working hypothesis concerning human existence and its aims and objects, which will dictate, or at least indicate, a definite line of approach to its problems."

David Bidney, Research Associate of the Viking Fund, the foundation that sponsored the entire volume, comes next with a stimulating study of the concept of meta-anthropology and its significance for contemporary anthropological science. "A genuinely scientific and realistic view of cultural dynamics will be one which is based on a healthy respect for the complexity of cultural life and for the reciprocal influence of subjective and objective factors. Only by keeping in mind the Platonic vision that integration, whether of culture or society, is essentially a matter of harmonizing the one and the many can this objective be attained." As if to prove that this is possible, the following essay by Professor Clyde Kluckholn, of Harvard, on the philosophy of the Navaho Indians, describes "not only Navaho ethics and values but also some of those highest common factors that are implicit in a variety of the doings and sayings of the Navaho."

Continuing in this same vein, Professor Francisco Romero, of El Colegio Libre de Estudios Superiores de Buenos Aires, discusses "Man and Culture," and Professor Northrop contributes a characteristically lucid analysis of ideological man in his relation to scientifically known natural man. Then, Professor Pitirim A. Sorokin, of Harvard, takes issue with Danilevsky, Spengler, and Toynbee in a short essay concerning the lasting and dying factors in the world's cultures. Finally, Gray L. Dorsey, Fellow of the American Council of Learned Societies, describes two

objective bases for a world-wide legal order. These are "found in the traditional cultures of what Maine considered the two significant types of societies. This means that the fundamental bases for a universal law are present in deep-lying, lasting cultural traditions of the world."

It is Dorsey, too, in almost his last sentence, who brings us round the full circle to the thoughts with which this review began, when he writes: "The legal order must be supported in the hearts, minds, and actions of men to be vital." There of course is the crux of the whole problem. There also is the opportunity for men who have confidence in the processes of education and persuasion. And for them this book will prove both an inspiration and a treasure house of ideas and information. All such will agree that Professor Northrop's endeavor and the labors of his galaxy of writers have not been in vain.

Cybernetics: A New Discipline

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HAVE YOU TAUGHT SOMEONE to drive a car lately? If not, perhaps you can recall how when you yourself were learning to drive, the car, in response to your instructions, veered first too much to the left, then too far to the right, and generally pursued an awkward zigzag course down the road. With training you or your protegé no doubt learned to pilot a car so that it proceeded smoothly, without jerks or wobbles, from one to the other of two given points by what you believed to be the shortest route consistent with the rules of the road and the curves involved. If these remarks bring to mind vivid recollections of the kind of experience just described, then you have already had good firsthand experience with applied cybernetics, and (whether you realize it or not) you already know something about the subject.

The word *cybernetics* is a neo-Greek expression coined to fill a need felt by Professor Wiener[1] and his associates for a single term, unprejudiced by previous usage, that could be used to designate the whole expanse of control and communication theory pertinent to the description, analysis, or construction of systems that involve (1) mechanisms (receptors) for the *reception* of *messages* or stimuli, (2) means (circuits) for *communication* of these to (3) a central *control unit* that responds by *feeding back* through the system (4) *instructions* that (will or tend to) produce *specific actions* on the part of (5) *particular elements* (effectors) of the system. To this end, the word *cybernetics* was therefore formed from the Greek word for *steersman*, κυβερνήτης (kybernetes). Besides having approximately the desired connotation, this Greek word is all the more symbolic on account of the fact that its Latin corruption, *gubernator*, is the origin of our word *governor*, and, Professor Wiener points out, the first significant paper on feedback mechanisms is the article published by Clerk Maxwell in 1868 on the theory of the purely mechanical feedback system represented by the governor of a steam engine, a device invented by James Watt to regulate the velocity of his steam engine under varying conditions of load.

The central concept in cybernetics is a feedback mechanism that, in response to information (stimuli, messages) received through the system, feeds back to the system instructions that modify or otherwise alter the performance of the system. It is important in cybernetics to distinguish *positive feedback*, which serves to increase what the system is doing in magnitude or direction, from *negative feedback*, which serves to oppose the performance of the system, e.g., to reduce its magnitude or change its direction. Thus, in psychology and neurophysiology one distinguishes between situations wherein an organism responds to a stimulus in such a manner as to acquire an increased amount of the stimulus (*adience*), and situations wherein the response is such as to reduce the amount of the stimulus received (*avoidance*). In practical affairs, positive feedback is generally scrupulously avoided, since, if uninhibited, it will lead obviously to an extreme state. Two cases of positive feedback in moderation that come to the reviewer's mind are (a) adience of young mammals, which is essential to proper receipt of nourishment and to keeping warm; and (b) the regenerative circuits used in radio receivers in the early days, to regenerate and thereby intensify a weak signal. Negative feedback mechanisms, on the other hand, are used widely, and are of considerable interest, for they embody what is generally implied by the word "control."

As we have noted, the governor of a steam engine is an example of a purely mechanical (negative) feed-

[1] *Cybernetics: or control and communication in the animal and the machine.* Norbert Wiener. New York: John Wiley; Paris, France: Hermann et Cie, 1948. Pp. 194. $3.00.

back mechanism. In the original form designed by Watt, two balls attached to pendulum rods swing on opposite sides of a rotating shaft, and their position, via a mechanical linkage attached to a collar about the shaft, controls the opening of the steam valve, reducing the opening when the balls rise (increasing speed), and widening the opening when the balls fall (decreasing speed). Since the balls are thrown outward and upward by centrifugal force (the magnitude of which depends directly upon the angular velocity of the shaft and ultimately upon the amount of steam admitted through the valve) and are pulled down by their own weight, the system seeks a compromise state which with good design is achieved promptly and is preserved. In consequence the engine operates uniformly at the prescribed speed unless the load is changed, calling for more or less steam, which adjustment the balls promptly achieve. Bad design of the governing mechanism, on the other hand, may send the valve into violent oscillation and cause the engine to behave much like an automobile in the hands of a beginner who treads too heavily upon the gas, causing the car to lurch ahead, so that he releases the pressure of his foot upon the throttle, whereupon the car slows up abruptly and he increases pressure upon the throttle and produces another lurch ahead, and so forth.

The ordinary thermostat by which the heating of a house or a room is regulated is perhaps a more familiar example of a negative feedback system. More commonplace, but probably least familiar of all, is the nervous system, which contains a control mechanism that makes possible the performance of our voluntary actions. With training and experience a child can pick up a pencil, cigarette, or piece of candy, without awkward gropings; but if the control mechanism in the cerebellum is in poor adjustment, as in the infant, considerable "hunting" takes place before the hand finds the object; and if the mechanism is damaged by injury to the cerebellum, attempts to pick up an object may (probably will) send the arm into violent oscillations of *cerebellar* or *purpose tremor.*

Although *feedback* (and the *control* over a mechanism thereby effected) constitutes the central theme of cybernetics, there can be no feedback and no control unless there is communication of the incoming message (stimulus) from the receptor to the feedback mechanism and transmission of its message (instructions) to the effector parts of the system (e.g. to the valves of a machine, or to the muscles of an animal). The theory and techniques of *communication* are, therefore, fundamental parts of cybernetics. Since communication of a message may be represented quite generally as a times series of impulses, this brings in the study of *time series,* and especially the statistics of time series, in view of the problem of separating the message carried by a series of impulses from the random "noise" mixed in with the basic signal. Consequently, the theory of wave filters and other devices used in telephone, radio, and television circuits for unscrambling messages from mixed series falls within the province of cybernetics, as does also the theory of fire control devices for directing gunfire. These latter must resolve the true course of a target from the mixed and often contradictory impressions received (as a result of observational errors arising from turbulence of the atmosphere, if the sighting is optical; from static, if radar is used) and compute a predicted position at which to direct the shell. Consideration of such automatic fire control equipment for directing gunfire leads naturally to consideration of automatic sequence-controlled electronic and mechanical computing machines. The analogies of such systems to the brain and the nervous system are tempting.

In *Cybernetics,* the first volume of a projected series, the author has undertaken to survey the entire field of control and communication theory and its various ramifications. He has been remarkably successful in pointing out the similarities and equivalences (from a mathematical viewpoint) of many diverse phenomena of man, animal, machine, and society; and has thus achieved a certain unified approach to problems "of vital importance to psychologists, physiologists, electrical engineers, radio engineers, sociologists, philosophers, mathematicians, anthropologists, psychiatrists, and physicists." To this impressive list might be added also astronomers, geologists, meteorologists, geneticists, and others. Later volumes are to cover specific applications in detail. (A second volume, *Extrapolation, interpolation and smoothing of stationary time series, with engineering applications,* by the same author, is scheduled for publication in June 1949.) The present volume exhibits the value of cybernetics as an analogical tool; its sequels are to demonstrate the power of the method in particular contexts.

In approaching the present volume, the reader should not be discouraged by the mathematical discussions, and should attend more to the spirit of the mathematics than to its detail. Fortunately, the essential ideas are amply expounded in the verbal text; so that on first reading, at least, one can profitably read along at a good pace, omitting the more troublesome mathematical portions. The tremendous scope of this book is evidenced by its chapter headings: (I) Newtonian and Bergsonian Time; (II) Groups and Statistical Mechanics; (III) Time Series, Information, and Communication; (IV) Feedback and Oscillation; (V) Computing Machines and the Nervous

System; (VI) Gestalt and Universals; (VII) Cybernetics and Psychopathology; (VIII) Information, Language, and Society. A panoramic view of the whole is given in the 33-page introduction, which ends with a pessimistic view of the future of human society and a note of discouragement concerning the possibility of developing an exact science of economics or sociology. The reader who is neither a mathematician nor an engineer may profitably skip from the introduction to Chapter IV, on first reading. Chapters II–IV are of particular interest to the mathematician and the electronic engineer; and Chapter III is of interest to the student of theoretical statistics, in view of its new approach to the notion of the amount of information in a series of data.

The text of the American edition, which appears to be a reproduction of the Paris edition (either by use of the same plates or by photographic means), unfortunately contains a fairly large number of typographical errors. The present volume is also without an index. It is to be hoped that these shortcomings will be rectified in future editions of the present volume and given due consideration in the publication of other volumes of the projected series.

Cosmic Science and the Social Order

Harlow Shapley, *Harvard Observatory*

THE MARIA MITCHELL of a century ago and the Albert Einstein of the present come together naturally in a joint review because along with their concern for sanity in social affairs neither slackened in ardor for knowledge of the universe. Maria Mitchell followed well-established lines in her astronomical work, but broke new ground in advocacy of higher education for women. Einstein broke new ground in the interpretation of the universe, then joined the hard fight for the lives and rights of free men.

The books under review[1] are the story of the life and work of a New England spinster of the middle of the 19th century, and the story of a portion of the deep and revolutionary thought of a master mind of this first half of the 20th century. Both volumes are readable and thought provoking.

In her volume, *Sweeper in the sky,* Miss Helen Wright has completed a study to which she has devoted many years. Herself a former student of astronomy in Vassar College, where Maria Mitchell, 80 years ago, spent some of the most fruitful years of her life, Miss Wright explored most thoroughly the earlier career of this outstanding woman scientist—this native of historic and romantic Nantucket Island, where her banker-scientist father guided her early astronomical studies and explorations. The Nantucket of those days was something of a cultural center, visited by the famous poets, writers, and scientists, and the Mitchells did much to make the local culture.

Sweeper in the sky is a volume of charm and unusual interest, largely because it deals with significant phases of mid-19th-century America. The lives and principles of the orthodox Quakers of Nantucket, and

the young girl scientist's gradual, struggling withdrawal from the credal inflexibility of that religious group, make a fascinating tale.

From being a quiet, intense observer of the stars, Maria Mitchell rose suddenly to international fame through the discovery of a comet in 1847. The comet soon disappeared, but her fame remained. She was

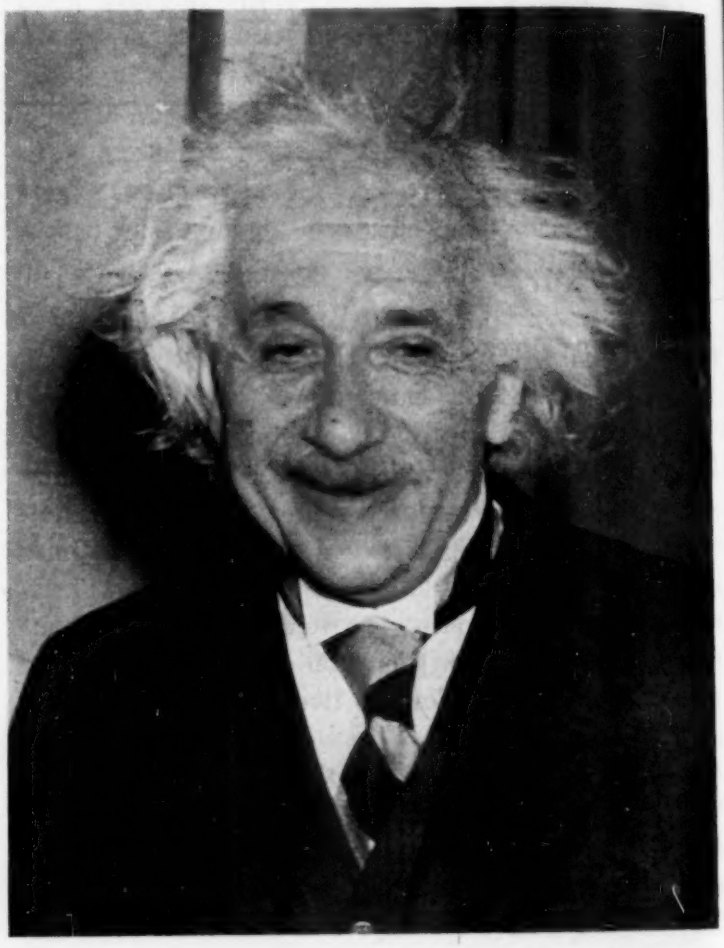
[1] *Sweeper in the sky.* Helen Wright. New York: Macmillan, 1949. Pp. vii + 254. $4.00.
The universe and Dr. Einstein. Lincoln Barnett. New York: William Sloane, 1948. Pp. 127. $2.50.

elected in 1848 the first woman member of the American Academy of Arts and Sciences, and remained the only woman member throughout the 19th century. It was not until 1943 that the somewhat stiff gentlemen of that ancient organization, which started with George Washington and John Adams in the early membership, yielded to the ferment that had quietly been planted by Maria Mitchell and her sister intellectuals; the Academy then elected four women to membership. In 1850 Maria Mitchell was elected to the AAAS—another first.

That one ordinary comet, discovered with the small telescope on Nantucket Island, brought Maria Mitchell the prestige that her spirit and abilities merited. Without the recognition and responsibility, her career might have been obscure. If she had not been the first to detect the comet, it would have been picked up by another—in fact, it was independently discovered by Father da Vico of Rome a few days later. But the astronomers and public of old, as of now, attach a rather spurious importance to the individual who anticipates his colleagues by a few hours or days in seeing (or photographing) and officially reporting a new comet. Frequently we hang his name on the comet, and nowadays give him the Donahue Comet Medal, established and operated by the Astronomical Society of the Pacific. A century ago the King of Denmark established himself as a patron of the sciences, arts, and publicity by bestowing his royal blessing, and a medal, on the first discoverer of a new telescopic comet. Maria Mitchell got that medal and many congratulations from important people of the era. She was embarrassed by the acclaim, of course, but her family, her town, and her country were proud.

Just one hundred years ago this month, the Denmark King's medal was put on display at a meeting of the American Academy of Arts and Sciences. At that same meeting there were discussions, by Benjamin Pierce and others, of the motions of the recently discovered major planet, Neptune. That was an exciting decade, astronomically—there was the monstrous comet of 1843, the discovery of Neptune, and the founding at Harvard of the first large astronomical research institution in America—probably these events helped to enhance the wide fame of the studious lady of Nantucket. Her trip abroad (she traveled at times with Nathaniel Hawthorne and family) was scientifically a triumphal tour. She was rated along with Mary Somerville, the British mathematical astronomer and science writer, as the top woman scientist of the mid-century. On her travels she carried the first photograph of a star—a latchkey provided her by the Bonds of the Harvard Observatory.

It was natural, of course, that the hard-thinking, industrious and shy Maria Mitchell was asked to join the faculty of the new Female College founded at Poughkeepsie by Matthew Vassar. All those who are interested in the early history of that pioneer educational enterprise will find *Sweeper in the sky* an instructive introduction. They will also like the tales of the Nantucketers and will chuckle over the foibles of the religious and intellectual leaders of Maria Mitchell's time and admire their virtues. The reader of Lincoln Barnett's *The universe and Dr. Einstein* will not find many chuckles in his small volume. They



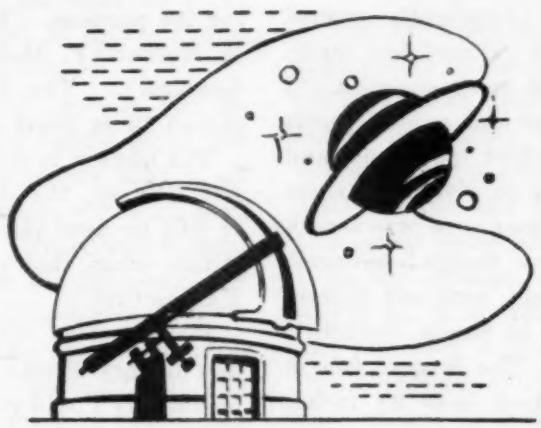
are, however, going to find something that to many appeals more deeply. They are going to find, for the first time in their inquisitive lives, that they really can "catch on to what this here relativity business means." Mr. Barnett, a journalist who has graduated into professional authorship, favored me with part of his manuscript, asking if I would not check up on this and that. A good many manuscripts come my way, and I confess that Mr. Barnett's pages were about to receive the kindly treatment that is customary, I am afraid, when laymen handle cosmogony, or the nature of universal forces, or the theory of relativity. But the first paragraph revealed that the author has understanding and a facility of explaining the well-nigh inexplicable. He has done the best job I have seen in presenting partially the nature of the relativistic universe, and the history of Einstein's thoughts as the still incomplete picture unfolded in his mind.

Mr. Barnett, with degrees from Princeton and Columbia, has turned directly to the masters at those institutions, to Hermann Weyl, Valentin Bargmann, H. P. Robertson, and William W. Havens, Jr. But I venture to suggest that the clarity of the presentation of Einstein's universe did not come from the masters—they know too much!

In his introduction to the volume, Einstein says that "the main ideas of the theory of relativity are extremely well presented. Moreover, the present state of our knowledge in physics is aptly characterized. The author shows how the growth of our factual knowledge, together with the striving for a unified theoretical conception comprising all empirical data, has led to the present situation which is characterized —notwithstanding all successes—by an uncertainty concerning the choice of the basic theoretical concepts." Einstein also warns against the sort of popularization that "succeeds in being intelligible by concealing the core of the problem and by offering to the reader only superficial aspects or vague allusions, thus deceiving the reader by arousing in him the deceptive illusion of comprehension."

Perhaps Mr. Barnett's readers may believe they comprehend more than is possible from a volume which must put its only mathematical symbolism in a brief appendix. But whether or not they are somewhat deceived by the clarity of the presentation, those who have never looked thoughtfully into the problems of the nature of the world in which they live are going to turn from this volume a bit startled and starry-eyed; and many will wish it were twice the length so that some of the ideas too briefly touched upon could have been spread out and illuminated. They will want to know more of the development of some of these surprising concepts—of the primordial field, the structure of space, atomic transmutation, and the fundamental mystery, still defying us, of clearly and unambiguously linking up the nature and forces of the microsomes with the nature and forces of the subatomic.

The portrait of Maria Mitchell, used as an illustration in* Sweeper in the sky, *was painted by H. Dassel in 1851. Dr. Einstein's photograph is reproduced here by permission of Science Service.



Comments and Communications

Do Fish Fall from the Sky?

In view of the prevailing skepticism about rains of fish, my own observations of this phenomenon may interest the readers of *Science*.

A rainfall of fish occurred on October 23, 1947 in Marksville, Louisiana, while I was conducting biological investigations for the Department of Wild Life and Fisheries. In the morning of that day, between seven and eight o'clock, fish ranging from two to nine inches in length fell on the streets and in yards, mystifying the citizens of that southern town. I was in the restaurant with my wife having breakfast, when the waitress informed us that fish were falling from the sky. We went immediately to collect some of the fish. The people in town were excited. The director of the Marksville Bank, J. M. Barham, said he had discovered upon arising from bed that fish had fallen by hundreds in his yard, and in the adjacent yard of Mrs. J. W. Joffrion. The cashier of the same bank, J. E. Gremillion, and two merchants, E. A. Blanchard and J. M. Brouillette, were struck by falling fish as they walked toward their places of business about 7:45 a.m. There were spots on Main Street, in the vicinity of the bank (a half block from the restaurant) averaging one fish per square yard. Automobiles and trucks were running over them. Fish also fell on the roofs of houses.

They were freshwater fish native to local waters, and belonging to the following species: Large-mouth black bass (*Micropterus salmoides*), goggle-eye (*Chaenobryttus coronarius*), two species of sunfish (*Lepomis*), several species of minnows and hickory shad (*Pomolobus mediocris*). The latter species were the most common. I personally collected from Main Street and several yards on Monroe Street, a large jar of perfect specimens, and preserved them in Formalin, in order to distribute them among various museums. A local citizen who was struck by the fish told me that the fish were frozen; however, the specimens I collected, although cold, were not frozen. There is at least one record, in 1896 at Essen, Germany, of frozen fish falling from the sky. The largest fish in my collection was a large-mouth black bass 9¼ inches long. The largest falling fish on record was reported from India and weighed over six pounds.

The fish that fell in Marksville were absolutely fresh, and were fit for human consumption. The area in which they fell was approximately 1,000 feet long and about 75 or 80 feet wide, extending in a north-southerly direction, and was covered unevenly by fish. The actual falling of the fish occurred in somewhat short intervals, during foggy and comparatively calm weather. The velocity of the wind on the ground did not exceed eight miles per hour. The New Orleans weather bureau had no report of any large tornado, or updrift, in the vicinity of Marksville at that time. However, James Nelson Gowanloch, chief biologist for the Louisiana Department of Wild Life and Fisheries, and I had noticed the presence of numerous small tornadoes, or "devil dusters" the day before the "rain of fish" in Marksville. Fish rains have nearly always been described as being accompanied by violent thunderstorms and heavy rains. This, however, was not the case in Marksville.

Certainly occurrences of this nature are rare, and are not always reported, but nevertheless they are well known. The first mention of the phenomenon was made by Athanaseus in his *De pluvia piscium* nearly two thousand years ago, and E. W. Gudger, in his four collective articles, reports 78 cases of falling fish from the sky. There is no reason for anyone to devaluate the scientific evidence. Many people have never seen tornadoes, but they do not doubt them, and they accept the fact that wind can lift and carry heavy objects. Why can't fish be lifted with water and carried by the whirlwind?

Oyster Laboratory, Biloxi, Mississippi A. D. Bajkov

The Linda Hall Scientific Library, Kansas City, Missouri

Readers of scientific literature are watching with great satisfaction the impressive growth of the Linda Hall Library in Kansas City. This library, by agreement, is to be devoted exclusively to books and periodicals on science and technology. It should become the mecca for all scientific readers of the western central states.

The library was created eight years ago by an endowment in the will of Herbert F. Hall, a business leader of the vicinity. An estate of sixteen acres, four miles south of the business district of Kansas City and adjoining the campus of the University of Kansas City, was provided for the purpose. The library bears the name of the wife of Herbert F. Hall (both Mr. and Mrs. Hall are now deceased). The first books and periodicals were purchased three years ago.

The library is only a few blocks away from the Nelson Art Gallery, the Art Institute, and Rockhurst College. It will be near the grounds of the Midwest Research Institute when that organization moves to its new site in Kansas City.

Five trustees, appointed by Mr. Hall, decided that the new library should cover "the field of basic science and technology" and minister freely to the needs of "science scholars and research men." The library works in close cooperation with other libraries of Kansas City, and, under the terms of the will, it serves the scientific and technical book needs of the University of Kansas City faculty and student body. The University has transferred most of its books on science to the shelves of the Linda Hall Library and all science periodicals necessary to the science departments of the University are now provided by the Linda Hall Library.

Books and periodicals are coming in so rapidly that hardly any accurate statement can be made now on what

the library has to offer. A recent estimate places the number of bound volumes over 100,000. More than 2,200 current periodicals are now coming in by subscription and by gift. The collection covers such fields as those of the basic sciences and the industrial arts, and includes meteorology, building and construction, aeronautics, printing, mining and metallurgy, and radio.

The bound periodicals of many scientific academies and societies extend without interruption back to the 17th and 18th centuries. For some of the more recent sciences the sets are complete—for example, all of the United States Geological Survey publications are provided, and several sets of the State Geological Survey publications are nearly complete.

The reader may sit in a reading room of the library and have books brought to him by a library attendant from floors above and below or from the adjacent building. Or, in the periodical reading room, he may ask for any of the 2,200 files of periodicals, including the latest issues. The present full-time staff is eleven people, including four professional librarians.

JOHN R. BALL

University of Kansas City

Atmospheric Pressure and Bird Flight

While the following observations have no direct bearing on the discussion of bird migration, they may contribute something as regards the effect of atmospheric pressure on bird flight.

In the fall of 1933 I was aboard a slow cargo ship on the great circle course, Lisbon to New York. A small West Indian hurricane had started north about the time we left Lisbon; it should have been entirely dissipated long before we "went over the hill." But the storm was also slow, and was still meandering up the coast when we reached the Newfoundland Banks. By calculation, it was due to strike inland at New York at the time we would be off Boston; our course was shifted to the eastward, to run well outside and ride in behind it.

This proved rather to be a collision course, for the storm recurved and followed the Long Island coast outward, with the result that we ran squarely into it off Nantucket, in a quadrant and at an angle which no navigator would deliberately have chosen. There was nothing then to be done but heave to and hope for the best; and, in due time, the storm center passed directly over us.

Any hurricane is a major disturbance, but fortunately this one was not of maximum area or intensity. It was, however, still intact and perfectly formed; the center, of course, was characterized by clear sky, absence of wind, and the confused seas piling one atop another from the four quadrants. The unexpected feature, however, was the fact that the center area was clearly defined by the presence of innumerable birds, land and shore birds of all sizes which had been sucked up and carried along, as helpless as if confined within a room except that the progressing storm forced them to keep in constant flight.

Starved, parched and exhausted, those that could sought refuge on the ship; rails, rigging and lifelines were covered with them; the decks were awash with drowned bundles of feathers. More than 30 kinds of birds were counted, including an owl. Many were taken inside and every effort was made to save them, but only one, a long-legged shore bird, survived.

The most pitiful case was that of a great black wild duck which tried desperately to beat its way to the ship from only a few yards off. Its "flight ceiling" was so low that its powerful wings could not raise it above the crest of the seas, which were about mast high. Three times we watched it fly straight into an oncoming sea, and emerge, still "flying" from the other side; the fourth time it did not reappear.

Whether pressure and other atmospheric factors accounted for the low flight that caused this one and so many others to drown, or whether it was weakness alone, I do not know. It was certainly the pressure system that placed them in this tragic situation. This example would seem to be the reverse of that cited by C. Suffern of England, whose redwings were carried along the *outer edge* of the pressure system, presumably on the wind. These were in the wind-free center, but were carried out to sea because they could not break through the walls of wind. It was curious that there were no sea birds among them; yet the storm, although it had hugged the coast, had not gone inland at any point. Evidently they had been picked up by the fringe winds and blown into the center, much as the seas were dragged in. Since it was entirely involuntary on the part of the birds, this mass displacement could not, of course, be considered a migration; but it might be assumed that migratory birds would attempt to avoid such pressure systems.

DOROTHY FORD MAYHEW

Institute of Geographical Exploration,
Harvard University

On the High Prices of Scientific Books

This is in the nature of a protest against the present high prices of scientific books. In recent years the cost of books has doubled and tripled until it is now virtually impossible for many scientific workers to own volumes they need and this is to say nothing of the poor student, who has to struggle to pay for texts that are absolutely essential.

In my opinion, a personal library, however small it might be, is an inestimable aid to a student in gaining and *retaining* a grasp of his subject. The present situation forces many to sell their current texts to pay for the ones needed in the following semester.

The prices of many articles are falling, and we can only hope that books will follow suit. As a remedial measure, might I suggest the European procedure, whereby books are issued in both unbound and bound form. This would reduce the price of many books by about 25 percent. I see no reason for paying $4.00 for a 147-page book—the price asked for a recent publication.

JOHN R. LOWRY

General Foods Corporation,
Hoboken, N. J.

Book Reviews[1]

The science of biology today. Trofim Lysenko. New York 16, N. Y.: International Pubs., 1948. Pp. 62. $1.25.

On July 31, 1948, Academician Trofim Lysenko delivered his presidential address to the V. I. Lenin Academy of Agricultural Sciences in the USSR. That address forms the substance of this small book. It must indeed be read to be believed.

The address began with a dissection of Darwinism in the light of the opinions of Marx and Engels. Soviet scientists are strong Darwinists. They acknowledge, to be sure, the existence of certain errors in Darwin's thought, traceable chiefly to the pernicious, "reactionary" influence of Malthus. In plain language, what the Soviet Darwinists reject is the Theory of the Struggle for Existence within species and of the Survival of the Fittest. What remains of Darwinism after this evisceration is the theory of the effects of use and disuse in modifying hereditary characteristics, and the elaborate and completely unsupported theory of pangenesis.

Having made Darwin equivalent to Lamarck, Lysenko passed on to demolish the ideology of his *bête noire,* August Weismann. Having done this to his satisfaction, he posed the question of the inheritance of acquired characteristics, said flatly that the Lamarckian propositions are "quite true and scientific," and interpreted them as equivalent to maintaining that the "qualitative variations of the nature of plant and animal organisms depend on the conditions of life which act upon the living body, upon the organism." Having completed this *tour de force,* it follows that "the Mendel-Morgan teaching, which is metaphysical and idealist in its essence, denies the existence of such dependence, though it can cite no evidence to prove its point." The essence of "idealistic" error is to divide "the living body into two separate substances: the mortal body (or soma) and an immortal hereditary substance, germ-plasm."

In subsequent passages the evolutionary views of the great Russian morphologist Schmalhausen were attacked and the studies of population genetics conducted by Dubinin and his associates were ridiculed as sterile and impractical. This paved the way for the apotheosis of Michurin, Lysenko's own guide and mentor, and introduced the subject of vegetative hybrids. Michurin has claimed that: "Any character may be transmitted from one strain to another by means of grafting as well as by the sexual method." One "shakes" the nature of a vegetable organism by various means, renders it plastic in heredity, and then by grafting induces a transfer of characteristics.

Having deplored the teaching of Mendelian-Morganian genetics in Soviet universities and institutes, Lysenko stated that "under the influence of Michurian criticism of Morganism young scientists with an insight into questions of philosophy have in recent years come to realize that the Morganist views are utterly alien to the world outlook of Soviet people." At least, they knew on which side their bread was buttered!

The one piece of evidence for his views actually mentioned by Lysenko in this address was the conversion of hard spring wheat (durum) into soft winter wheat (vulgare), at a single step, after two to four years of autumn planting. It is difficult to see what this genome mutation from a 28-chromosome wheat to a 42-chromosome wheat has to do with the argument for the inheritance of acquired characteristics. "Classical" geneticists are selecting adaptive mutants by means of environmental conditions in hundreds of laboratories. The real question, which is whether such mutants fail to appear or appear with a lower frequency in the absence of the said conditions, is a question which Lysenko avoided altogether.

At this point the speaker ended. A discussion ensued, and Lysenko arose to answer a specific question regarding the attitude of the Central Committee of the Communist Party toward his report. The answer: the Committee had examined his report and had approved it. In other words, Lysenko's doctrines were completely victorious. The debacle of scientific reason which followed was complete—expurgation of reactionary genetics from all textbooks, reorientation of university staffs, purging of noted geneticists and evolutionists, hurried recantations by middle-of-the-roaders before it was too late.

In his concluding remarks Lysenko outdid himself. ". . . Heredity is inherent not only in the chromosomes, but in any particle of the living body . . . for heredity is determined by the specific type of metabolism. You need but change the type of metabolism in a living body to bring about a change in heredity." Lysenko brought forward as evidence a tomato plant. It was a vegetative hybrid between a strain with entire leaves and red fruit, used as the stock, and another with pinnate leaves and yellow fruit, used as the scion. Most of the plants from the seeds produced by this graft hybrid were like the stock or scion on which they were borne. But six plants from seeds borne on the stock had pinnate leaves and yellow fruit. And this was reported to have happened again in some seeds produced by normal entire-leaved, red-fruited F_1 plants derived from the stock. This interesting report ignores all the previous work done on graft hybrids, begun by Winkler in 1907, and the discovery of chimeras so produced, in 1910. The one new claim, which should certainly be checked by workers elsewhere, is that a chimeral condition can be transmitted

[1] Complete index to all book reviews is given on pages 429–430.

through the seed for several generations. But, of course, Lysenko himself does not believe in chimeras.

The final blasts on this notable occasion were directed at the dependence of Mendelism-Morganism on chance. It is imperative to quote these statements, which illuminate the entire Soviet attitude toward science:

"All the so-called laws of Mendelism-Morganism are *based entirely on the idea of chance.*"

"'Gene' mutations . . . appear fortuitously . . . the direction of the process of mutation is also fortuitous. Proceeding from these invented fortuities, the Morganists base their experiments, too, on a fortuitous choice of substances that might act as mutation factors, believing that they are thereby acting on their postulated hereditary substance, which is just a figment of their imagination, and hoping thereby to obtain fortuitously what may by chance prove to be of use. According to Morganism, the separation of the so-called maternal and paternal chromosomes at reduction divisions is also a matter of pure chance. Fertilization . . . does not occur selectively, but by the chance meeting of germ cells. . . .

"*On the whole, living nature appears to the Morganists as a medley of fortuitous, isolated phenomena, without any necessary connections and subject to no laws.* Chance remains supreme."

"Unable to reveal the laws of living nature, the Morganists . . . reduce biological science to mere statistics. . . . Mendelism-Morganism is built entirely on chance; this 'science' therefore denies the existence of necessary relationships in living nature and condemns practical workers to fruitless waiting. There is no effectiveness in such science. With such a science it is impossible to plan, to work toward a definite goal; it rules out scientific foresight. . . . Physics and chemistry have been rid of fortuities. That is why they have become exact sciences. . . . *By ridding our science of Mendelism-Morganism-Weismannism we will expel fortuities from biological science.* We must firmly remember that *science is the enemy of chance.*"

"Long live the party of Lenin and Stalin, which discovered Michurin for the world and created all the conditions for the progress of advanced materialist biology in our country." (Italics in original.)

BENTLEY GLASS

Johns Hopkins University

The Royal Society Empire Scientific Conference, June–July 1946. (2 vols.) Edinburgh, Scotland: Morrison and Gibb Ltd., 1948. Vol. I: 828 pp.; Vol. II: 707 pp. (Illustrated.) 2: 2: 0 net.

The Empire Scientific Conference had its beginnings in discussions by representatives of the British Ministry of Supply and the British Commonwealth Scientific Office in Washington with representatives of the Royal Society. Following a conference called by officers of the Royal Society and attended by representatives of Canada, Australia, New Zealand, South Africa, and India, a British Commonwealth Science Committee was set up under the chairmanship of Sir Henry Dale and with Dr. Alexander King as Secretary. The report of this Committee, published in April 1943, proposed an Empire Scientific Conference to be convened as soon as possible after the war. In January 1945, expenses for the Conference were allocated by the Treasury in the amount of £15,000. A Policy Committee for the Conference began work early in 1945 under the chairmanship of Sir Alfred Egerton. The Conference itself took place June–July 1946, in London, Cambridge, and Oxford. There were 114 delegates representing different countries within the British Commonwealth. The larger delegations included: Australia—9, Canada—15, India—14, South Africa—7, and United Kingdom—38. The Steering Committee, composed of 12 leading scientists, included Sir Robert Robinson, president of the Royal Society, and the four other chief officers of the Society, and was under the chairmanship of Sir Henry Tizard. The Conference was organized mainly around 15 major scientific topics for each of which a steering group was appointed with a chairman, a recorder, and from six to ten other representative scientists as committeemen. The first three days were devoted to a stock-taking review of scientific organization: 1) in the United Kingdom; 2) in Canada, New Zealand, and the Colonial Empire; and 3) in Australia, South Africa, and India. Volume I, pages 43–298, presents the prepared papers, discussions, charts, and tabular matter relative to the organization of scientific research and much concerning current (1946) research.

In reviewing such a large report it is possible only to give an outline. Six of the fifteen main topics of the Conference are reported in about 500 pages of Volume I. These topics in order are: A—Outstanding Problems in Agricultural Science in the Empire; B1—Medical Science: Physiological and Psychological Factors Affecting Human Life and Work under Tropical Conditions and in Industry; B2—Etiology and Control of Infectious and Transmissible Diseases, particularly those which are insect-borne; C—Science of Nutrition, including Nutritional Status of the Indigenous Peoples of the Colonies; D—Aerial Mapping, including the Use of Radio Technique in Ordnance Survey; and E—Measures for Improving Scientific Information Services, including Indexing, Abstracting, Special Libraries, and Microfilms. Each of these sections begins with a listing of the personnel of the steering group, followed by a brief digest of the report on the subject, a general statement, and finally, the Conference recommendations in reference to research and further development.

Nine topics, to which as many full morning sessions were devoted, are reported in Volume II. Briefly listed, these topics were the following: F—Interchange of Scientists, including Discussion on the Future of the Scientific Liaison Offices That Have Been Established during the War; G—Empire Cooperation in Science with Existing and Projected International Organizations; H—Physical Standards and the Use of Units, Terms and Symbols; I—Collection and Interchange of Scientific Records and Experimental Materials, including Discussion of Risks

Involved in the Distribution of Plants, Seeds and Animals; J—Land Utilization and Conservation throughout the Empire; K—The Need for a Coordinated Survey of the Mineral Resources of the Empire; L—Natural Resources of the Empire and the Chemical Industries That Are or Might Be Based on Them; M—Post-War Needs of Fundamental Research; and N—Coordination of Scientific Work within the African Continent.

The Conference in some evening discussions gave consideration and arrived at recommendations in reference to five large topics: Cosmic Rays, Fish Culture, Geochemistry, Hormones, and Fisheries (see Volume II, pages 529–662); the full calendar of the Conference is given on pages 663–677. At the end of each volume there is a complete index for both volumes, comprising about 30 pages. The index gives names of speakers and discussants (not presiding officers and organizing and committee personnel) and of scientific topics of discussion and related entries. A long list of traveling fellowships and scholarships open to students and research workers is provided in Volume II, pages 37–82.

The topic of broadest interest was "morning subject (m)," The Needs of Research in Fundamental Science After the War. The material on this subject for discussion by the delegates consisted of a previously completed report of the Royal Society on Post-War Needs of Fundamental Research, produced by eight committees representing, respectively, Physics, Chemistry, Biology and Biochemistry, Geophysics, Geology, Geography, Meteorology, and Oceanography. The most general recommendations developed were: I) The mechanism for guiding long term research in fundamental science in each country of the Commonwealth should be carefully reviewed in order to foster fertile research work in all important subjects. II) Since needs of the future will require a great increase in the number of scientists, plans for extending basic research in any field should be supported by measures designed, coordinated, and put into operation in the educational system of each country for increasing the number of trained scientists able to carry out such research plans.

This two-volume report is an important and many-sided scientific document. From it one gains an over-all view of the pattern of modern scientific research and development as forming a huge triangle with "university science," "industrial science," and "government science" at its three corners. Science research planners, administrators, financial backers, laboratory workers, educators, and technical and popular science writers will all find the materials in these two volumes worthy of examination and discussion. The report is epochal in the field of assessment, survey, and planning for the advance of science and its applications. It is a model for the preliminary organization and conduct of such conferences, and the Royal Society has again, it seems to the reviewer, demonstrated foresight and outstanding leadership in creating and guiding the Empire Scientific Conference and in making its report available to the public.

WALTER R. MILES

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Liberty Hyde Bailey: a story of American plant sciences. Andrew Denny Rodgers, III. Princeton, N. J.: Princeton Univ. Press, 1949. Pp. 506. (Illustrated.) $7.50.

As these words are written Liberty Hyde Bailey is entering the 92nd year of his life, and is still collecting plants, both living and herbarium specimens, still publishing, still reaching out with his mind, at an age when other men, if they are able to think at all, have mentally "retired," with opinions formed and portals closed to the acquisition of any further and considerable body of knowledge. Not so this dean of American botanists, who once said that he had planned to take 25 years to study the science of botany, 25 to practice it, and 25 to enjoy it. Actually, he has, in each quarter-century since his majority, done all three things at once and is still learning, practising, and enjoying a science which no one in his day ever did more to encourage, broaden, and make vivid.

Many men have gone deeper in their branches of botany; no man in America was ever a better all-around botanist. Bailey is most famous, of course, as an editor, geneticist, and teacher, and as the first American to treat horticulture as a serious science, with the broadest social implications. But beyond all this he is a philosopher—having reached the highest thing any scientist can be—who brings together the varied interests of his own and his contemporaries' minds, and from them evolves not a schematic theory of the world as it ought to be, but an attitude toward the world as it is. A man who can accomplish this, and live, too, a happy and noble personal life like Liberty Hyde Bailey's has indeed fulfilled the high destiny that (we like to think) is the function of a man of science.

All this, and more, much more besides, has been told in *Liberty Hyde Bailey*, by Andrew Denny Rodgers, in the fifth title of his scholarly series of biographies that constitute a history of American botany from the days of Torrey and Mr. Rodgers' ancestor, Sullivant, and the era of systematics and exploration a century ago, down to the present with all its diversities and complexities. Those of us who, like the present reviewer, have read every word so far are grateful to Mr. Rodgers for the precision and breadth of treatment, and the understanding appraisal of the botanists who form the subject of his unusual sort of historical writing. At the same time it must be said that, as writing and as history this is, rather, reference work—the materials for a history. As biography it is a compilation—meticulous, thorough, and lucid—but not living portraiture. Nothing is omitted, nothing is highlighted; a reasonable monotone is the result. By comparison, passages from writings of Liberty Hyde Bailey, as quoted in this book, are so full of natural poetry and vitality of thought and phrase as to make one wish that Professor Bailey would write his own biography, even at the cost of further researches upon palms.

Yet we shall all look forward to further titles from Mr. Rodgers' pen. We hope that he will not only continue with his painstaking researches in the present era, but will carry the history of American botany back to the

days of Linnaeus's American correspondents—Colden, Bartram, and Garden—and that he will take for his models in biographical writing such authors as Boswell, Macaulay, Fiske, and Parkman, whose scholarship never suffered from their artistry.

DONALD CULROSS PEATTIE

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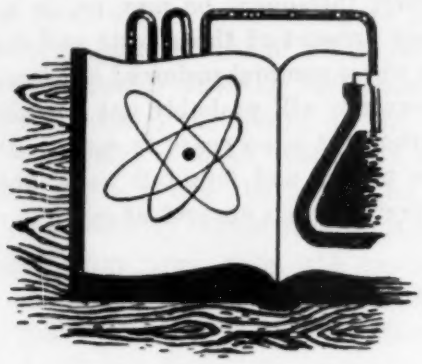

Scientific foundations of vacuum technique. Saul Dushman. New York: John Wiley; London: Chapman & Hall, 1949. Pp. xi + 882. (Illustrated.) $15.00.

This book is a monument to an era just concluded and a marker and a storage depot for the future. The era began with the invention of the condensation pump, and it ended spectacularly when vacuum went to war—high vacuum for radar and the fissioned atom, grand vacuum for magnesium and penicillin. During the intervening 30 years the gas-filled X-ray tube gave place to the Coolidge vacuum tube; the tungsten lamp and electronics came to maturity, and the molecular still was born. A regiment of subsidiary apparatus and measuring instruments sprang up and vacuum plumbing graduated from an unwelcome necessity to a hobby, then to an art, and recently to a science.

In 1922 Dr. Dushman published a little book called *High vacuum* which at once became the guide to a new territory. Shortly afterwards, many larger and more comprehensive books were written, mostly in the same pattern, but none placed the matter more succinctly. It has been evident for 10 years, however, that much new material has accumulated. It has been equally evident that the one man to make the authoritative compilation is Dr. Dushman because, as associate director of the General Electric Laboratories at Schenectady, he has witnessed or himself created nearly all that has transpired.

The *Foundations* is a reference book for scientists and advanced engineers; it does not deal with vacuum in the chemical process industries. The first four chapters—perhaps the best in a very good book—cover the theory of gases (and even the highest vacuum on earth still contains much gas). The next chapters on pumps and gauges are authoritative and comprehensive rather than selective. The later chapters dealing with adsorption, getters, solubility of gases in metals, and diffusion of gas through metals, are encyclopedic. On vapor pressure, the dry or electronic field is fully covered, but pump fluids only meagerly. The references and indexes are splendid. It is difficult to assess the merits of a book that has no rivals; suffice it to say that it stands alone. Practically every laboratory, regardless of its avowed purpose, will find a place for this book.

KENNETH C. D. HICKMAN

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Quantum mechanics. Leonard I. Schiff. New York: McGraw-Hill, 1949. Pp. xii + 404. (Illustrated.) $5.50.

Schiff's new textbook *Quantum mechanics* will be a very great help to anyone who studies this fundamental subject, which by now is taught to every student of physics. There is no other field in physics which poses more and harder problems to the teacher. Explaining the fundamental concepts of quantum mechanics is the most difficult of tasks, and no really clear way of doing it has yet been found. However, every student must not only be acquainted with these fundamental concepts, but also be able to apply them in his research work. Quantum mechanics also uses a great number of very complicated mathematical formalisms to which the student must be introduced. This is the easier part of the course, and too little emphasis is usually given to the exposition of the fundamentals.

The present book is distinguished in this respect from most of the older, widely used textbooks. The first chapter contains a well-presented description of the fundamental concepts of measurement and complementarity. It introduces the reader into the problematics of the subject but does not relieve the more serious student from the study of books like the ones by Dirac or Kramers, and the classical papers of Bohr. The Schroedinger wave equation is introduced in the second chapter by using the experimental relation between frequency and wavelength. This emphasizes the connection with experimental facts, which is sometimes missing in more dogmatic representations. The following chapters are very much along conventional lines, but are written with great care and with emphasis on detailed and elegant derivations. The book differs from the usual introductions into quantum mechanics by a strong emphasis on collision theory. This is a great advantage in view of the increasing application of quantum mechanics to nuclear collision problems.

One notices a change in style beginning with Chapter 9, when the problems of many particles are treated and when radiation is taken into account. Less emphasis is placed on detailed description and the book takes on more of the character of a survey than before. These chapters include discussion of identical particles and the spin of the electron, and a semi-classical treatment of radiation and of the spectra of atoms and molecules. The last three chapters form a separate unit, on the relativistic wave equation, and the quantization of the wave fields, and a short introduction into quantum electrodynamics; they represent, therefore, what is taught in most schools in a separate course on advanced quantum mechanics.

A few details could perhaps be criticized from the point of view of the reviewer, who has probably ac-

quired a too-narrow idea of how to teach this subject. One of the most important concepts for the understanding and practical application of quantum mechanics is angular momentum. The treatment of this concept could have been more extended. There is, for example, no reference in the book to the fact that the angular momentum operators are the operators of infinitesimal rotations. The addition of angular momenta as applied to many-particle problems is mentioned, but has not received a very thorough discussion. This textbook, as well as most of the others, refer the reader to the book by Condon and Shortley, whose treatment, however, is much too exhaustive—the reviewer has found that it frightens away most of the students who want to study it. It is hoped that some textbook will provide an elegant and simple treatment of this field. The spin of the electron does not get the attention it deserves. The fact that the electron wave function has two components is derived in too formal a manner. A discussion of the transformation properties of these components, if the coordinate system is rotated, is necessary for the understanding of the spin.

Schiff's book has many values for teachers and students, not the least of which is its collection of first-rate problems. Too few textbooks on quantum mechanics can be used for a graduate course. There are many ways of teaching the subject and there is a great need for textbooks with different approaches. Although the present book in many respects follows the conventional lines, it does bring in new ideas and approaches and will contribute to a better understanding and better teaching of quantum mechanics.

VICTOR F. WEISSKOPF
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Physical aspects of colour: an introduction to the scientific study of colour stimuli and colour sensations. P. J. Bouma. New York: Elsevier (U. S. distributors for Philips Technical Library, Eindhoven, The Netherlands), 1948. Pp. 312. (Illustrated.) $5.50.

It is a pleasure to review this remarkable summary of the principles and techniques of modern measurement of color. Dr. Bouma spent the last two years of his life to produce what he knew would be his last work, and he has achieved a brilliant climax to a distinguished career in illuminating engineering.

Starting from a novel yet perfectly sound approach, Dr. Bouma presents the concepts and laws on which the measurement of brightness is based—the Maxwell color triangle and the standard ICI colorimetric coordinate system and its relation to dominant wavelength and purity, to color temperature, to boundary, ideal, optimal, and full colors, and its use in the reduction of spectrophotometric data. He then passes to visual colorimetry, defective color vision, discrimination of color differences, the Munsell color system, and hue and saturation of object colors in connection with chromatic adaptation of the eye.

Dr. Bouma does not skip over the hard parts, but goes in simple language to the knot of each problem, often with a mathematical proof. The book is further remarkable for its completeness. All important colorimetric techniques are not merely described; they are appraised with consummate skill and judgment.

In spite of the direct style and excellent translation into English, the book is not easy reading. It has to be studied, not merely read. The facts and concepts of modern colorimetry cannot be adequately grasped by the layman, however intelligent he may be, in a few hours. Here is a clear account of these facts and concepts by a world master whose comprehension of the recent extensive American literature will probably not be matched by an American author for some years to come. Dr. Bouma's book meets a unique and long-felt need, and should be available to every serious student of color.

DEANE B. JUDD
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Practical spectroscopy. George R. Harrison, Richard C. Lord, and John R. Loofbourow. New York: Prentice-Hall, 1948. Pp. xiv + 605. (Illustrated.) $6.65.

The authors of this extremely useful and interesting reference book have operated in recent years the spectroscopic laboratory of the Massachusetts Institute of Technology and have felt (quoting from the preface) "the need of a text and reference book that would help the worker in any branch of science to evaluate the aid which the techniques of spectroscopy might lend to the solution of his problems. In our attempt to fill this need, we, as a physicist, a chemist, and a biophysicist, respectively, have tried to synthesize our three viewpoints in a way that would be useful to all who use, or might use, the techniques of experimental spectroscopy."

They have produced a book that will be valuable and interesting to all of us who have made constant use of the spectrograph, and will fulfill the requirements of the beginner as well. For example, in the chapter on the photography of the spectrum (page 154) I find a suggested routine to follow in transferring a plate from the box to the plateholder in a perfectly dark room, in order to be spared the embarrassment of finding, on turning up the lights, an open box of plates awaiting disposal.

The beginner will find in the first chapter a very brief history of the development of the spectroscope, its construction and operation, and its use in physics, chemistry, biology, medicine, metallurgy, food research, and criminology. Chapters 2 to 5 are devoted to the selection of spectroscopic instruments and the use of prisms and diffraction gratings, together with the fullest details on their adjustment and methods of illumination.

Chapter 7 covers the photography of the spectrum, dealing with practically everything connected with the selection and development of plates and with common defects in spectrum photographs and how to avoid them. Chapter 8 offers a very full description of the various types of light sources for spectroscopy, low temperature thermal emission, metallic arcs, high and low pressure mercury arcs, spark discharges, and vacuum tubes.

Chapter 9, on the identification of spectrum lines, measurement of wavelengths, and the determination of minute traces of impurities with the comparator, closes with a dscription of Harrison's remarkable automatic comparator, used at the Massachusetts Institute of Technology since 1938. This machine is capable of measuring in two minutes a spectrum plate 20 inches long on which are recorded as many as 2,000 spectrum lines. It records on a motion picture film, to seven-figure precision, the wavelengths in Angstrom units of all of the lines, along with a curve of density showing their position and intensity. Unfortunately, the record on the strip of film reproduced is on such a small scale that the numerals can't be read. This is also the trouble on page 163 in the case of the sensitivity curves of various emulsions.

Chapter 10 covers very fully the modern quantum theories of atomic spectral series, energy levels, and the Zeeman and Stark effects (the former effect furnishes a method of classifying lines into series). The chapter closes with a treatment of the Pauli exclusion principle and the periodic table.

Chapter 11 is devoted to describing the highly complicated fine structure of the spectra of molecules (their rotation and the vibration of their atoms give rise to corresponding energy levels, superposed on the electronic levels), and to explaining the part these energy levels play in producing various types of absorption spectra.

In Chapters 12 to 14 we are back again in the laboratory with 420 pages devoted to methods for measuring the intensities of spectrum lines or absorption bands by means of radiometers, photoelectric cells, and photographic emulsions. Some of the instruments are automatic, like the extremely complicated photoelectric spectrophotometer of Hardy, and the instrument of Harrison and Bently previously mentioned.

Chapters 15 and 16 deal with the qualitative and quantitative analyses of materials. In the two following chapters the treatment of infrared and "Raman" spectroscopy is far more extensive than is usual in books on general spectroscopy, and Dr. Lord's contrast and comparison of these two types of observation will be of great interest to everyone engaged in the study of molecular structure and in qualitative and quantitative chemical analyses.

A minor mistake was made on page 474 in crediting E. F. Nichols with the invention of the widely used method of residual rays, and not mentioning Rubens, who originated the method and named the radiations "rest strahlen." Nichols, who was working under the direction of Rubens, had found that a quartz plate had a very high coefficient of reflection in the region between 8 and 10 microns, but it was Rubens who foresaw that multiple reflections from a number of plates would eliminate all of the very intense radiations of shorter wavelength. Rubens developed the method and published it under joint authorship with Nichols. The description of the method of "focal isolation" of a narrow region in the remote infrared (described on the next page) omits mention of the very essential circular metal disk covering the center of the quartz lens or the fact that two such lenses are usually employed.

Chapter 19 covers the spectroscopy of the vacuum ultraviolet and presents diagrams of the vacuum chambers housing the optical parts. The final chapter offers a much longer treatment of interferometric spectroscopy than is usual in textbooks, covering the Lummer Gehrcke plate, Fabry and Perot's etalon, the Michelson transmission echelon, and the reflecting one of W. E. Williams.

The very complete references to specific points, in the form of footnotes, and the general references at the end of the chapters supply the details, often desired, but usually found wanting in a book like this, for lack of space.

R. W. Wood

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Handbook of radioactivity and tracer methodology. William Siri. (With contributions by Ellsworth C. Dougherty, *et al.*) (Air Force Technical Report No. 5669.) Washington, D. C.: Office of Technical Services, Department of Commerce, 1948. Pp. 867. (Illustrated.) $20.00.

This handbook should be an invaluable aid to the many scientific specialists who wish to apply the use of radioactive or stable isotopes to the investigation of their special interest. I should say that it would be particularly useful to the biologist or chemist who needs these techniques but who has been handicapped by a lack of information about the physical methods which must necessarily be used for measurement of the appropriate rare isotope. Such an individual will find the necessary background information on nuclear physics in the first section of this handbook. This section also contains a wealth of range and cross section data which will be of particular interest to the physicist or biophysicist. The second section of the handbook is devoted to a discussion of the various instruments used for measurement of isotopes. The information in the chapter on calibration and use of G-M counters, as well as the detailed discussion on preparing biological samples for counting, is indispensable to the novice and probably could be read with profit by many of the more experienced workers in the field. The chapter on autoradiography is somewhat general and, in view of the rapidly expanding interest in this technique, the next edition of the handbook should perhaps treat it in greater detail.

A third section deals with the biological and medical applications of isotopes. The useful isotopes are discussed as regards their use in both tracer experiments and therapeutic applications. A chapter on the biological effects of natural radioactive elements closes this section.

The fourth section consists of an extensive bibliography including some general references and a complete list arranged according to the elements investigated.

In general it may be said that this handbook contains information available in no other single source. While particular stress has been laid on its usefulness to the biologist or chemist, it should be an invaluable reference

for the graduate student in physics or biophysics as well.

The one respect in which this book fails to qualify as a bible for the beginner in radioisotopic research is its lack of a health physics section. This may be a calculated omission, based on the belief that the biologist or chemist must associate himself with a specialist in health physics if he wishes to avoid serious health hazards. However proper this attitude may be, and regardless of who makes the radiation measurements, it is the duty of any responsible investigator to inform himself about the radioactive hazards he and his subordinates might incur in carrying out their work. The widely spread use of radioactive isotopes may result in injurious radiation exposure if sufficient background information on health physics is not generally available. If this handbook becomes as widely distributed as its excellence deserves, it might well serve to supply this basic health physics information.

JOHN B. HURSH

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Some aspects of the luminescence of solids. F. A. Kröger. New York-Amsterdam-London: Elsevier Publ., 1948. Pp. xi + 310. (Illustrated.) $5.50.

Although the war ended almost four years ago, conditions insuring an easy access and exchange of available scientific information have not yet returned. A great amount of valuable research has been done in some European countries during and after the war. However, because of the limited availability and circulation of European journals, the results of these researches are not widely known in this country. It is fortunate indeed that Dr. Kröger, who has contributed so much to the knowledge of the luminescence of solids, undertook the task of presenting in this monograph the results of his experimental researches and combining them with a critical review of the existing theories of the luminescence processes in solids. Dr. Kröger's association with one of the leading industrial laboratories,—the Philips Laboratories in Eindhoven, Holland—has enabled him to use freely all the rich resources of information amassed there in the course of many years of research.

The first chapter discusses schemes of energy levels for pure solids and for solids with lattices disturbed by the presence of impurities. A more detailed description is given of the atomic orbit approximation for the case of ionic lattices. Other topics are the processes of light absorption and emission, and the nature of metastable states of the activation, sensitization, and energy transfers through the lattice. Finally, a classification of all known luminescences of activated phosphors is attempted in the form of tables accompanied by very exhaustive references to original papers. The next four chapters consist of results of experimental work on particular systems—tungstates, molybdates, and luminophors activated by manganese, uranium, and titanium. The skillful identification of the tetravalent manganese ion as activator for the emission of a red band (Chapter II), and the correlation between the positions of the absorption edge and the maximum of the emission for tungstates and molybdates (Chapter III) are especially interesting. The sixth and final chapter compares the experimental results on the influence of temperature on efficiency of luminescence with the explanations of the quenching processes proposed by Mott and Seitz, Möglich and Rompe, and Klasens and Schön. It is shown that in some cases the excitation energy is directly transformed into vibrational energy (Mott-Seitz), in others the energy is dissipated via intermediate states (Klasens-Schön). A useful table of classification for all known types of temperature quenching is included. An appendix provides a few data on experimental techniques.

In general, the monograph is both interesting and informative. Great care has been exercised in both theoretical chapters to present a clear picture of the processes in solid luminophors and to establish a well-defined terminology for these processes. One section seems a little too condensed and could benefit by some additional explanations. This section deals with the energy level scheme. The use of expressions like "energy cost" (energy requirement) and "cheap transition" (low frequency transition), which are probably the result of a too-literal translation from Dutch into English, is unfortunate. In other respects the book is very readable and the reviewer feels that it fills an important gap in the literature on luminescence of solids. The successful effort made by Dr. Kröger to organize a considerable number of previously uncoordinated facts and correlate them with corresponding theoretical considerations is especially welcome in a field of physics where the richness of experimental data seems to be in contrast to the meagerness of our understanding of fundamental processes.

S. MROZOWSKI

Photoswitch Incorporated,
Cambridge, Massachusetts

Vision and the eye. M. H. Pirenne. London, W.C.1, Engl.: Pilot Press, 1948. Pp. xx + 187. (Illustrated.) 12/6.

As noted in the foreword by W. S. Stiles of the National Physical Laboratory of England, this little book offers a treatment of selected topics in vision rather than an attempt to cover the entire field in its many ramifications. The subjects selected for treatment are apparently those in which the author has done research and made scientific contributions; this makes the book particularly authoritative and forceful.

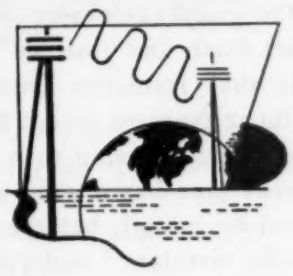
The first five chapters discuss in detail the several phenomena involved in image formation by the eye, from the physical and physiological points of view. A lengthy treatment follows of questions relating to the way in which the particle or quantum nature of light enters as a factor in determining visual response, and the experiments of Hecht, Shlaer, and Pirenne are quoted and discussed in detail. The final third of the book is devoted to the subject of color vision, except for a single chapter which relates to binocular vision.

It is hard to see exactly what audience the author had in mind for this book, since some portions seem elemen-

tary whereas others are quite sophisticated. Surely it would not serve as a textbook, but rather as a reference book for those who are looking for a comprehensive treatment of certain important phenomena of vision, from the physical rather than the psychological point of view. The book appears to be in the tradition of that distinguished American biophysicist, the late Selig Hecht, a fact which will be appreciated by the many admirers of Hecht's work in vision.

STANLEY S. BALLARD

Tufts College



Microwave magnetrons. George B. Collins. (Ed.) (Massachusetts Institute of Technology Radiation Laboratory Series.) New York-London: McGraw-Hill, 1948. Pp. xviii + 806. (Illustrated.) $9.00.

As a result of the great program of work in radar that was set off by British success in exploiting the magnetron, a previously more or less familiar laboratory microwave generator, it is natural that a tremendous amount of information concerning it was accumulated during the war, both here and abroad, and in both university and industrial laboratories. This important volume of the M.I.T. Radiation Laboratory Series summarizes that knowledge in a very thorough manner. It will of course be of most interest and value to those who have had some experience with the device or are contemplating its use. With its great wealth and detail of material, this book will undoubtedly be the standard reference work for years to come.

For those who have little familiarity with the magnetron and want to know more, an introductory chapter summarizes some of the elementary facts about its operation. Following this introduction, the work is divided into sections: resonant systems, analysis of operation, design, tuning and stabilization, and practice. The last section includes not only details on the fabrication of magnetrons but also measurements of their properties and descriptions of some of the various types. Of necessity, the first two sections include much analysis which has a formidable look; these sections, important as they are, will consequently appeal to a smaller group of readers than the other more descriptive sections.

For all the variety of detail to be found in the book, there are nonetheless some omissions and some points too briefly discussed. For example, there is no discussion of two types of magnetron resonators that, although they are not used, practically every worker in the field invents at one time or another. There are other minor omissions —the problem of harmonic generation, the mechanical changes that may be produced in the resonator system by extreme operation, and the effects of cathode eccentricity. The cathode and magnetron life might have been more thoroughly discussed. Other widely used magnetrons, particularly those developed in England, with which the Radiation Laboratory was not so closely connected, might well have been included as typical magnetrons. A brief discussion of magnetron development in enemy countries during the war would have been illuminating and not necessarily irrelevant.

It is to be expected that such a work, done by many writers in short periods of time and in widely separated locations, should include errors. Those few that came to notice are errors in detail—references to material or sections not included or pictures mislabeled. This is all small criticism. ***Microwave magnetrons*** represents a very large task excellently done.

PAUL L. HARTMAN

Cornell University

Cosmic rays. L. Jánossy. Oxford, Engl.: Clarendon Press; New York: Oxford Univ. Press, 1948. Pp. xiii + 424. $10.00.

The investigation of cosmic rays since their discovery by Victor F. Hess in his balloon ascensions in 1911–1913 has become one of the most important branches of research in modern physics. Since 1926 the hypothesis of Hess as to their extraterrestrial origin has been accepted and proven to be correct. Numerous investigators, of all nationalities, all over the globe, are engaged in these researches, but aside from some brief monographs and symposia reports, this book by Janossy is the first compendium on cosmic rays. The author, senior professor in the School of Cosmic Physics at the Dublin Institute for Advanced Studies, has himself contributed many original investigations in the field during the last 15 years.

The book opens with an historical introduction sketching the trend of discoveries and the successive problematical changes. It discusses the penetrating power of cosmic rays, the question as to the nature of cosmic rays, the cosmic ray particles (positron and meson both discovered in the cosmic radiation by Anderson), the geomagnetic effects, and the question of the origin of cosmic rays, particularly the meson. The introduction thus serves as a summary and the various chapter headings follow this outline. Since cosmic rays are high energy particles the experimental technique for their detection and the theory of high energy interactions are discussed in some detail. Each of the experimental techniques—ionization chambers, counters, cloud chambers and the photographic plate method—is briefly described. (The photographic plate method, unfortunately, is discussed all too briefly; an appendix mentions some of the beautiful and important new experiments of Powell and his school at Bristol.)

A chapter on the theory of fast collisions serves as an over-all introduction and foundation for the theoretical discussion which follows in later chapters. This discussion is based on classical and semiclassical theories and the quantum mechanical treatment is omitted. Each

chapter opens with a presentation of the experimental evidence, illustrated by tables and graphs; this is followed by detailed theoretical discussion, a comparison between theory and experiment, and an interpretation of the experimental results. An appendix on the statistical treatment of observations and auxiliary tables for the cascade theory computations will be useful to the research worker and student. The great compass of literature covered will make this compendium an invaluable help to anyone working in cosmic ray physics. It should be pointed out, however, that the student will have to make use of the original literature quoted, since so much is digested in the treatise that it is impossible to give detailed derivations for every formula.

It should be mentioned that, although the author addressed this book primarily to the specialist, he has followed it up with a small text for the general reader—*The frontiers of science series: cosmic rays and nuclear physics*—which will be useful to students as an introduction to the larger volume.

K. LARK-HOROVITZ

Purdue University

Vacuum tube amplifiers. (Massachusetts Institute of Technology Radiation Laboratory Series.) George E. Valley, Jr., and Henry Wallman. New York-London: McGraw-Hill, 1948. Pp. xvii + 743. (Illustrated.) $10.00.

This book, the 18th volume in the Radiation Laboratory series, discusses amplifier types that are used in radar systems, but are more generally applicable to the whole field of instrumentation, control, and special communication devices. It is recommended to engineers in these fields as a valuable reference and to others as a good introduction to the subject.

The introductory chapter treats the analysis of linear circuits by operational methods. Subsequent discussions cover video amplifiers; wide band, high frequency amplifiers; low frequency, band pass amplifiers; and direct-coupled amplifiers. In each case a theoretical analysis of pertinent circuitry is supplemented by a detailed exposition of design principles. Particular attention is directed to those factors affecting gain, band width, dynamic range, and fidelity of response. Much practical design advice is included. However, in some cases practical difficulties may not be sufficiently stressed. Inveterate optimists are warned against the suggestion (p. 193) that a stagger-tuned IF strip might be realized with only inductance tables, a soldering iron, and a pair of pliers. Final chapters cover the theory of amplifier noise, minimal noise design, and the measurement of amplifier noise.

The technical level of the discussion is uniformly high. The material presented is up to date and definitive of current design practice. Some of it has heretofore been available only in periodicals or in reports having limited circulation.

Excellent editing is apparent. The 14 chapters, separately written by 10 contributing authors, maintain very satisfactory continuity. Illustrations are plentiful and references adequate. The index appears too brief, but a detailed table of contents facilitates location of material.

J. G. REID, JR.

National Bureau of Standards

The face of the moon. Ralph B. Baldwin. Chicago: Univ. Chicago Press, 1949. Pp. xiv + 239. (Illustrated.) $5.00.

Over a period of several years, Dr. Baldwin has been studying the moon's surface particularly from photographs made at the great observatories, and his conclusions have been set forth and justified in his new book. His contention is that meteorite impact is solely responsible for all lunar features except the obvious blowholes that are lined up in curving rows in many regions of the moon. Lunar lava has altered many of the features thus produced by impact, but even the great Mare Imbrium, "tolerably circular," and 700 miles in diameter, is included as an impact explosion crater.

His too-rapid dismissal of slow igneous processes, in which he largely falls into the usual error of comparing lunar formations with present-day terrestrial volcanoes, will hardly serve to convince those who continue to wonder how craters 50 or even 100 miles in diameter can be only two or three miles deep, if formed by meteoritic bombardment. He discusses this problem in a chapter on "correlations," but somehow it doesn't quite convince. The violence of an impact explosion would have been so great that large craters, whose walls would be below the horizon for an observer at the center, could hardly have been formed. On a plane surface, perhaps it would be possible, but the moon's surface is too sharply curved.

But Dr. Baldwin's book is the only modern comprehensive championing of the impact hypothesis, which was advanced casually and intuitively in the past. No one has more intimately studied the lunar surface, with a view toward demonstrating the truth of the impact hypothesis, nor, for that matter, has anyone so completely discussed the terrestrial meteorite craters. In two chapters totaling 50 pages, Dr. Baldwin has given a very valuable description and discussion of the known and suspected impact craters on our own planet. It is somewhat amazing, however, to find him quoting, with a straight face, the weird "contraterrene" hallucination of La Paz, in connection with the great 1908 Siberian meteorite fall.

Other important sections of the book are his discussions of the lunar atmosphere and hypothetical lunar history during the period outlined by the theory of tidal evolution. This latter section is a very well thought out attempt to account for the obviously different ages of the lunar features.

It is a good and valuable book, and it does not matter that it will not convert many who now believe in an igneous origin of the lunar craters. Any discussion of the moon's features by someone as thorough as Dr.

Baldwin is a welcome contribution to the somewhat neglected astronomy of the solar system.

ROY K. MARSHALL

University of North Carolina

Island life: a study of the land vertebrates of the islands of eastern Lake Michigan. (Cranbrook Institute of Science, Bull. No. 27.) Robert T. Hatt *et al.* Bloomfield Hills, Mich.: Cranbrook Institute, 1948. Pp. xi + 179. (Illustrated.) $4.00.

Insular plant and animal populations have always held a peculiar fascination for the student of natural history, partly because they provide opportunity to observe, record, and deduce without the harassment of the almost innumerable impinging factors that must be reckoned with in a comparable mainland study. Here there is land, there, water; the boundary line is sharply drawn, confining the terrestrial fauna, for the most part, within the area it circumscribes.

Island life is a progress report presenting the results of seven years' study of such an insular fauna. The study, jointly sponsored by the Cranbrook Institute of Science and the University of Michigan, covers 17 islands lying off the Lower Peninsula of Michigan. Mammals, birds, reptiles, and amphibians are considered, both as to distribution and as to habits that have effected the presence or absence of certain forms.

The study is well conceived, particularly in that it includes research into the geological and cultural history of the islands. The geological history, specifically the postglacial history, indicates that, following the recession of the glacial sheet, the water level dropped to around 200 feet below its present level. This provided land bridges between the islands and the mainland, but there seems little evidence from the faunal lists that these land bridges contributed materially to the distribution of the various vertebrates considered. In part, this may be due to the fact that the lake level subsequently rose around 300 feet, covering all the smaller islands, and the bulk of the larger ones. In any case, the authors hesitate to ascribe the present distribution of any form primarily to land bridge invasion.

The cultural history is interesting to the extent that man has superimposed certain introduced species (gray and fox squirrels, raccoon, and deer) extirpated others (elk, cougar, wolf, bear) and provided temporary haven for certain of man's common commensals (house mice, wharf rats, and English sparrows). The greatest single human influence seems to have resulted from the cutting of the original forest, opening the islands to many edge-dwellers that would not otherwise be there at all.

Just how the majority of terrestrial vertebrates reached the islands is open to speculation. Some undoubtedly came of their own volition—over the ice, through the water, or through the air. Some may have come via the land bridges. It is probable that some came in by drift, and evident that others were brought in by man.

The authors have been thorough in their consideration of the material at their disposal. However, one cannot help but feel that the summation may have been somewhat premature. Nearly every page poses questions that must go unanswered pending further investigation. It might be wished that one of the participating institutions would set up a permanent biological station on some one of the islands, and embark upon a 10- or 20-year program of study. Only thus could such phenomena as the relative paucity of species on the islands, as compared to the mainland, be explained. Even the largest island, Beaver, 58.4 square miles in area, and with nearly the same number of plant communities as the mainland, sustains less than one third the number of animal species.

As a progress report, *Island life* is excellent. It is well illustrated, the faunal lists are well annotated, and the analyses of the results to date are intriguing. As a stimulant to speculation and to further research, it is outstanding. The serious ecologist and vertebrate zoologist might ask for a more detailed record of specimens, localities of collection, and habitats, perhaps with maps. Such an expansion of the work would have made it more valuable to future field workers.

DONALD M. HATFIELD

Berkeley, California

Studies on bats and bat parasites. Olof Ryberg. Stockholm, Sweden: Univ. Lund and Zool. Lab. Agr., Dairy, and Hort. Inst. of Alnarp. Pp. xvi + 330. (Illustrated.)

This voluminous publication is taken from a greater study of many years' duration. It is largely a biological account or natural history of Scandinavian bats, but the information is equally relevant to the study of North American or other bats. Thirteen pages and eight plates deal with bat parasites and these chiefly the ectoparasitic *Diptera* of the family Nycteribidae.

The geographical distribution of bats of the world is dealt with by families in the text and in individual maps. Detailed maps are given for north European species. It appears that there are very few records of bats' approaching the Arctic Circle. Few, if any, occur in strictly polar regions, and none apparently in the treeless tundra, where these predominately cave and arboreal mammals could hardly be expected to be found. Ryberg remarks on the difficulty of establishing the northern limit of bat distribution in Siberia because of the "inaccessibility of the Russian literature." In Iceland bats occur only as stragglers, two North American species having been taken during the second world war. Few species occur at the

southern tip of South America and none on the Falkland Islands. A compilation of altitudinal records shows few above 10,000 feet (3050 meters) with two doubtfully at 16,395 feet or 5000 meters, snowline on the peak of Mt. Orizaba, Mexico and near snowline in the Himalayas. This is curiously similar to the altitudinal distribution of ants.

Of the 17 families of bats comprising some 2000 known forms, hibernation takes place mostly in Vespertilionidae and in a few species of four other families.

The author reared bats successfully on a diet of *Tenebrio molitor* larvae with added vitamins. The Scandinavian species are all insectivorous and all drink much water. They fly to water surfaces and repeatedly dip the snout into the water as they fly over it. Besides their supersonic sounds the bats make buzzing sounds while flying and in connection with other activities, such as eating or sneezing.

The valuable embryological data include what is stated to be the first certain observation of triplet birth in the Old World. The author believes that he has obtained unquestionable evidence of pregnancy in the spring following fertilization in the autumn.

The plates consist of a heterogeneous assortment of small photographs, some not clear. They show very well, however, the nesting sites and the general habitus of the Scandinavian bats. A photograph of twin bats with only four instead of five toes is stated to be the first known case of hypodactylia.

The bibliography of 41 pages deals with world literature and is an important asset.

The author is to be congratulated on this excellent monograph, and it is to be hoped that the investigations on broad biological problems and parasites will continue. The University of Lund deserves credit for undertaking the publication of what in this country would be an expensive book.

NEAL A. WEBER

University of North Dakota

The avian egg. Alexis L. Romanoff and Anastasia J. Romanoff. New York: John Wiley; London: Chapman and Hall, 1949. Pp. xiii + 918. (Illustrated.) $14.00.

The title establishes the theme of this volume but it does not suggest its encyclopedic nature. As the authors state: "This book represents an attempt to compile all the facts known about the bird's egg." Their findings have been arranged into three main divisions: morphogenetic expression, biophysicochemical constitution, and bio-economic importance. There are 424 figures and a wealth of tables. The bibliography contains over 2,500 references, but unfortunately does not include the titles of the articles.

The book is written in clear and simple language and may be unstintingly recommended to a broad spectrum of readers, from the research worker to the laity. Serologists may be a bit annoyed at the references to "immunological" properties, and the bacteriologist will probably chafe because of the somewhat superficial coverage of the chick embryo, since the bibliography contains no citations of the work by Woodruff and Goodpasture or F. M. Burnet. But the book fills a real need.

MALCOLM H. SOUL

University of Michigan

Faune de France: Hyménoptères Tenthredoïdes. (No. 47.) L. Berland. Paris (VI^e^), France: Paul Lechevalier, 1947. Pp. 496. (Illustrated.) 1,500 fr.

This well-illustrated volume is the fourth monograph on Hymenoptera contributed to the *Faune de France* by the versatile and indefatigable Lucien Berland. Like the other three, which treat of the aculeate Hymenoptera exclusive of ants, this descriptive work on sawflies will prove a very useful adjunct to the American entomologist's library.

Following a very brief review of the morphology and biology of adult and larval sawflies, Berland enters upon the taxonomic analysis of all families, genera, and species of sawfly known to be represented in the fairly rich fauna of France or its immediate environs. The diagnoses are concise and lucid, and in the case of genera are generally supplemented by very satisfactory illustrations of the habitus of one or more included species, or of the anatomical characters employed in the keys. Appended to the descriptions of most genera are brief notes on the biology (generally food habits) and world distribution of their representatives. Where possible, much more extensive notes are given for each of the more than 500 species described. These include not only records of food plants and feeding habits of larvae, brief descriptions of larvae, sites of cocoon formation, parthenogenesis, and so on, but also extensive lists of parasites. Very valuable to the entomologists interested in the comparative biology of European and American sawflies is the careful and detailed documentation of these notes, a fact partially accounting for the large bibliography of about 500 references.

Supplementing the text are tables of information that are of special interest to collectors, economic entomologists, and more general biologists. There is a list of French sawfly species whose parthenogenetic attributes are known or conjectured, a list of sawflies known to be harmful to cultivated plants, and finally a list of plants, whether of economic importance or not, with their known sawfly consociates. A systematic index of more than 30 pages concludes the work.

As stated earlier, this book will be quite useful to students of the taxonomy of American sawflies. Representatives of about three-fourths of the more than 90 genera figured by Berland are found in this country, and Berland's illustrations of the habitus of numerous species will prove welcome supplements to the figures of isolated anatomical parts illustrating H. H. Ross's superb and indispensable *Generic classification of the Nearctic sawflies.* It is to be hoped that one day someone will do for the American fauna what Berland has done so well

for that of France. Aside from MacGillivary's almost useless treatment of the Tenthredinoidea in the *Hymenoptera of Connecticut*, there is still no single modern taxonomic work dealing with the classification to species of sawflies for any state, or sizable locale, in the United States.

KENNETH W. COOPER

Princeton University

Wildlife management: upland game and general principles. Reuben Edwin Trippensee. New York-London: McGraw-Hill, 1948. Pp. x + 479. (Illustrated.) $5.00.

Workers and students in the field of wildlife management have long looked for a textbook to report the information that has so rapidly accumulated since the publication in 1933 of Aldo Leopold's classic *Game management*. Trippensee's work accomplishes this purpose admirably in several phases of the field.

Dr. Trippensee has been a wildlife research worker and teacher for 20-odd years in the Lake States and New England. His discussions of wildlife problems and bibliographies amply reflect this long period of work.

About four-fifths of the text is devoted to discussing three broad classes of wildlife—farm, forest, and wilderness—and to summarizing information on the ecology and management practices for the various species of wildlife considered as typical of these broad divisions. In general the information is well presented, though its order offers some problems. For instance in describing the technique of "Evaluating the Rabbit Range" on page 34 it is suggested that the reader turn first to the section on "Evaluating the Pheasant Range," some 42 pages later. The material for the Lake States area is much better than that for the western or southern sections of the United States.

The remaining fifth of the book deals with "Miscellaneous Wildlife Relationships" and "Wildlife Administration." These two sections are in the main adequate and sound summaries of predator problems, game harvest, refuges, winter feeding, administration, and technical training in the field of wildlife management. However the chapter on variations in animal numbers seems inconclusive to the reviewer.

After defining cycles in a way that seems to ignore quantitative data (he speaks of "noticeable scarcity" and numbers that "attract attention" in referring to population densities) Trippensee seems to argue around the question, through constantly leaning towards the "cosmic theory" as a basis of cycles in animal numbers. By using averages, he may well have masked the variations in time between dates of periods of abundance. Much of the data presented indicates both a lack of uniformity in time interval and also a lack of uniformity in the causes of decline in animal populations. In view of this, the term "cycle" as he uses it has little meaning in the commonly accepted sense of the word.

The reader will note that such important forms of wildlife as migratory birds and fur-bearers are not mentioned in the review. Trippensee states that "these, with a section on game fishes, were written but not published because of the difficulty of publishing and marketing as large a volume." It is hoped that these sections will be made available at a later date.

WILLIAM H. MARSHALL

University of Minnesota

Larger imperforate Foraminifera of South-Western Asia: Families Lituolidae, Orbitolinidae and Meandropsinidae. Francis R. S. Henson. London, S.W. 7, Engl.: British Museum (Natural History), 1948. Pp. xi + 127. (Illustrated.) 1£ 10/–.

This work is on the Foraminifera of a relatively new area. Very little has been published on the older formations of this region. The Foraminifera of only three families are included, one of which is new. Besides this, 14 new genera, 27 new species, and six new varieties are described. The various forms have complex internal structures and the plates show many thin sections to illustrate these structures. A glossary of the many special terms is included, and keys to the genera of each of the three families are given. Detailed text figures show developmental stages and the relationships.

The development and phylogenetic relationships of various forms belonging to these three families are discussed in detail and add much knowledge to the early developmental stages in these complex forms. The bearing of these stages on the evolutionary development is quite complex and much is still to be discovered regarding their usefulness in determining the true relationships of the various genera and their position in a true classification of the groups. Many gaps are yet to be filled in by future studies. These discussions of the various stages and their relationships to one another and to stages of other groups should make a decided advance in our knowledge of the three Foraminifera families concerned. The work should inspire others to add to our knowledge and to check the various relationships.

JOSEPH A. CUSHMAN

Sharon, Massachusetts

Animals without backbones. (Rev. ed.) Ralph Buchsbaum. Chicago: Univ. Chicago Press; London: Cambridge Univ. Press, 1948. Pp. xii + 405. (Illustrated.) $5.00.

No one will be as startled or as excited about this new edition of a highly successful text as people were about the book in its original form in 1938; the novelty of the excellent illustrations and simple, direct style has worn off. Yet it is clear that while the former edition was going through its seven printings, Dr. Buchsbaum was busy finding ways to improve his book. The new version has grown by only 34 numbered pages, and most of this is in an added final chapter entitled "Further Knowledge." In this new section and the accompanying four new pages of gravure photographs, the student is introduced carefully to such helpful material as information on biological field stations, scientific journals, and biblio-

graphic procedure. A selected list of journals, advanced texts and treatises, and books on special aspects of the invertebrates is followed by a reprint of three scientific articles in their original form: "The Characters of *Pelmatohydra oligactis*" (Pallas) by Libbie H. Hyman; "Notes on Locomotion in *Pelomyxa carolinensis*" by Charles G. Wilber; and a short piece by W. L. Doyle and E. K. Patterson, "Origin of Dipeptidase in a Protozoan." These are presented in such a way as to encourage the student to make further acquaintance with biological literature.

Significant additions have been made to the photographic presentation of protozoans, sponges, and protochordates. New pictures of *Peripatus* and *Liguus* are especially striking. Photographs of living material have replaced pictures of museum models in several instances, and better cuts have been prepared from previous illustrations. Often the rearrangement of earlier illustrations has been surprisingly helpful, as for example in the case of the photographs of trapdoor spiders and nests. Only one cut, showing a pair of fruit flies, struck the reviewers as below the high standards set elsewhere. Better placement of the gravure pages, to correspond more closely with the text material, is another important improvement. All gravure pages now are numbered for easy reference; the new index draws attention to each illustration in its proper place.

LORUS J. and MARGERY J. MILNE
University of New Hampshire

Bacterial and mycotic infections of man. René J. Dubos. (Ed.) Philadelphia-Montreal: J. B. Lippincott, 1948. Pp. xiii + 785. (Illustrated.) $5.00.

Viral and rickettsial infections of man. Thomas M. Rivers. (Ed.) Philadelphia-London: J. B. Lippincott, 1948. Pp. xvi + 587. (Illustrated.) $5.00.

The first book, like its companion volume on viral and rickettsial infections of man, represents the combined efforts of several specialists in the field of infectious diseases to present a source of information primarily for medical students—in this case on bacterial and mycotic infections. As such, it may be considered a textbook of medical bacteriology.

Using the approach so ably elaborated by Theobald Smith, the stated emphasis is on host-parasite relationships; the biological characteristics of the invaders, the total response of the invaded, and the forces, natural and artificial, which may alter the balance in favor of the host are integrated to complete the picture. The first nine chapters, devoted to a consideration of general background such as history, the nature and properties of bacteria, the problems of infection, and the fundamentals of immunology, serve to elucidate the general philosophy of the book. The major part of the book, 25 chapters, dealing with a consideration of groups of bacteria and fungi with their special characteristics and disease-provoking potentialities, and therapeutic considerations of their clinical effects, presents a well-rounded picture of standard infectious diseases. Four concluding chapters consider sterilization, chemotherapy, epidemiology, and diagnostic procedures in general.

The book is printed with large type on hard finish paper which is well suited for the illustrations. Unfortunately, the size of the book is somewhat awkward; a single-column format with smaller pages, even though necessitating a thicker volume, would be easier to use.

On the whole, the book meets some of the needs of medical students. Representing as it does the work of many individuals, it might be expected to be more unevenly presented; that there is so little unevenness is to the credit of the editor. A few chapters suffer from too great a tendency toward a monographic style, and whereas they are excellent reviews for the specialist, they seem to be more involved than necessary for the beginning student. There is some minor duplication of material, but the different approaches of the authors prove stimulating. The chapter on the streptococci may be singled out as an excellent, up-to-date, and comprehensive review of an involved subject, presented in an exceedingly stimulating manner.

The bibliographies are adequate, but not as complete as might be desired.

This book should be of value to students, and could serve as a textbook; but its greatest worth, in the reviewer's opinion, will be as a reference volume for the initiated rather than as a primary source of information.

The field of human viral and rickettsial infections differs from the strictly bacteriological field in that it is not so well stabilized and also there has not been a plethora of textbooks on the subject. For these reasons the second book reviewed stands somewhat apart from its companion.

The subject is introduced in five chapters covering the nature of viruses and the techniques available for their study. A chapter on epidemiology stresses the special features of viral diseases but also covers the general problems of infectious disease transmission. A chapter on bacterial viruses, while not contributing directly to an understanding of human disease, is definitely in order as an aid to understanding virus behavior in general. The remainder of the 37 chapters cover in detail the specific human diseases caused by well-established viral and rickettsial agents, together with a few, such as exanthem subitum and infectious mononucleosis, for which the etiologic factors are still somewhat vague. In each case, a well-rounded picture of the clinical condition, the known

facts about the causative agent, and diagnostic procedures are brought together.

Although the book was written by a number of specialists, there is excellent uniformity of approach and evenness of presentation. The material is up to date and the coverage adequate. Since this book has but a single rival in its field as a recent source of the material, it might receive strong recommendation on the basis of relative cost; however, on its own merits it can be enthusiastically suggested as a solid foundation for anyone desiring a well-balanced presentation of the subject. It most definitely fulfills the need of a book on this subject for the medical profession, mature and neophytic, and it will be extremely valuable for the developing specialist in viral and rickettsial science.

WILLIAM S. PRESTON

University of Michigan

Dictionary of genetics: including terms used in cytology, animal breeding and evolution. R. L. Knight. Waltham, Mass.: Chronica Botanica; New York: Stechert-Hafner, 1948. Pp. x + 183. $4.50.

As an extreme example of the difficulties met with by readers of the literature of genetics and cytology, Franz Schrader, in his book *Mitosis* (1944) lists 27 terms that have been used by writers in English for a single minute specialized region (*spindle-attachment, centromere, kinetochore,* etc.) of the chromosome. As he states, his list is not complete. All will agree with him that there is no point in keeping alive the many names that have been applied to this small object since its first description 50-odd years ago.

Knight refers to this structure in his preface, where he lists nine of the 27 terms, plus a new one. He apparently had not seen the book *Mitosis,* since Schrader's name does not appear in the bibliography. We must also agree with Knight when he says that genetic literature would be more readily understood if writers had, where possible, used an existing term instead of coining a new one, and when he expresses the hope that writers will not continue to coin new words where suitable terms already exist. Now we may ask, how does Knight as a lexicographer meet the problem of synonymy; in particular how does he handle the chromosome region just mentioned? Wilson, in his classical work *The cell in development and heredity* (1925) called it the *spindle-attachment* and got along with this one term: neither in his index nor in his glossary does he give any of its 27 synonyms.

Turning to the body of Knight's *Dictionary* for an answer, one finds *spindle-attachment* listed and defined. Checking the other nine terms listed in his preface we find four—*attachment constriction, centromere, insertion region,* and *kinetic constriction*—alphabetically listed and defined. The definitions are in almost the same words as for *spindle-attachment.* Cross references indicate that the author considers these five terms as synonyms. The remaining five of the nine terms are listed alphabetically, and after each the reader is referred for a definition to one of the four terms just mentioned.

Although such duplication of definitions is not a general feature of the book, conservation of space might justify printing the definition once and listing all known synonyms, followed in each case by a cross reference only.

One cannot avoid speculating as to what brought about the profuse growth of synonyms in this glaring instance, as well as in the literature of biology in general. The origin of new terms for old objects may be in part adaptive change: the new terms may express more truly than the old the real nature of the entities. The term *spindle-attachment,* as used by Wilson, was accurate and descriptive so far as it went. But during the past 25 years some progress has been made toward understanding the object, both structurally and physiologically. Cytologists now agree that it is more than the region of spindle fiber attachment. Rather, it is regarded as a differentiated chromosomal structure which plays a dynamic role in the movement of the chromosomes during mitosis; hence *kinetochore,* a term suggested by Moore and recommended and used by Sharp in his *Introduction to cytology* (1934) and his *Fundamentals of cytology* (1943) is more descriptive.

Perhaps another cause for the multiplicity of synonyms among English-speaking biologists is isolation. Geographical or psychological isolation may account for the preference of British cytologists for the term *centromere,* introduced by Darlington in 1936, although it is admitted that this term is in many cases not an accurate one so far as indicating the linear position of the structure in the chromosome is concerned. The centromere may reside at any point along a chromosome except the extreme end.

The minting of unnecessary terms probably results also from the relative indifference of some authors to the interests of their readers—not to mention the possibility of their own occasional conceit or vanity.

Knight's *Dictionary* is not limited to modern terms, because, as the author states, students still read and need to understand the older books. Including older terms will, he hopes, help to deter authors from putting new meanings on established words.

For some of the entries, definitions are taken directly or with slight changes from the works of others. In these cases the original authors' names are added. It is not apparent to the reviewer why the names of some authorities are followed by dates and others are not. References to the 125 authors cited are given in the bibliography. The *Dictionary* contains about 3,000 entries. Derivations of terms are not given; nor are pronunciations.

Recalling the aphorism of Dr. Johnson that "Every other author may aspire to praise: the lexicographer can only hope to escape reproach," it is inevitable that critics will take exception to some of the definitions as well as to certain omissions and inclusions. This is anticipated by the author in his request for additions and corrections for subsequent editions. In general the definitions strike the reviewer as clear and concise. Very few outright errors have been noted in a sampling of numerous pages. The reviewer intends to take the author seriously and send suggestions to him. Since the best

of dictionaries, like the best of other compilations, are those that have been subjected to rigorous criticism, biologists will be performing a service to students and writers by giving Dr. Knight the benefit of their ideas.

Twelve pages of appendices constitute a valuable feature of the book. These include numerous commonly used statistical formulae and tables, among them a table of chi square that is more extensive than similar tables in most text books. There is an unusual table of "Distances Recommended to Avoid Seed Contamination," compiled from the recent literature. The book is attractively made up and is printed on a heavy grade of paper in clear and legible type.

EDWARD C. COLIN

Chicago Teachers College

General cytology. E. D. P. DeRobertis, W. W. Nowinski, and Francisco A. Saez. (Trans. by Warren Andrew.) Philadelphia: W. B. Saunders, 1948. Pp. 345. (Illustrated.) $5.50.

This readable and well-illustrated short text, originally published in Argentina, achieves a remarkably broad survey of modern cytochemistry, cell physiology, and cytogenetics. Its emphasis on cytoplasmic structure and the activities of "resting" cells reflects the profound shift in interest in the 25 years since Wilson's summary of classical cytology, with its concentration on chromosomes in dividing cells. Noteworthy features are accounts, previously reviewed only in symposia and monographs, of recent work on secretion, chromosome structure, "ultrastructure," membane permeability and enzyme systems, and descriptions of many ingenious techniques of physical and chemical cytology (occasionally emphasized at the expense of results or interpretations). In the reviewer's opinion, however, the book's principal contribution is pedagogical: The presentation of cytology as the synthesis of related facts customarily scattered through courses in "cytology," histology, physiology, biochemistry, genetics, and embryology. That the unity actually achieved is far less than ideal is no argument against either the validity of the innovation or the need for such a course at the senior or beginning graduate level. Rather, it is a challenging commentary on our state of knowledge.

The book is reasonably free from the twin curses of cytology: excessive and esoteric terminology, and "explanation" by definition or redescription. Each chapter has an up-to-date though incomplete bibliography. The emphasis is more zoological than botanical. The translation is clear, if not always polished. Occasional prominence given the authors' own work reflects their enthusiasm and directs attention to research in Latin America. Critical readers will note: a fair number of minor errors; omission of some pertinent modern contributions, for example, in the experimental analyses of cell division and of radiation effects; acceptance of some recent work with less reservation than perspective may justify; hypocritical embrace of certain Darlingtonian hypotheses; and inclusion of much primarily genetical material. However, such defects are remediable by a good teacher, and do not obscure the wealth of well-considered and accurate information presented. Few will agree that "Purely morphological cytology . . . has exhausted the study and description of various cellular structures," but also few will deny that here a stimulating step is taken toward the integration of biological, physical, and chemical data which must ultimately give us a unified and meaningful concept of the structure and functioning of the living cell.

JOHN B. BUCK

National Institutes of Health

Nucleic acids and nucleoproteins. (Cold Spring Harbor Symposia on Quantitative Biology, Vol. XII.) Cold Spring Harbor, N. Y.: Biological Laboratory, 1947. Pp. xii + 279. (Illustrated.) $7.00.

This volume is the second symposium on nucleic acids to appear in print within a year (cf. *Symposia Soc. exp. Biol.* Vol. 1). This coincidence reflects the current wide interest in nucleic acids as an important cell constituent and a possible key to some of the fundamental problems of cellular biology. Although the contents of the two symposia overlap in part, the wealth of material and the fluid state of research in this field, as well as the absence of definitive conclusions, make duplication a rather desirable feature. The reviewed symposium, organized by M. Demerec, included contributors from Belgium, France, England, Sweden, and the U.S.A.—among them J. M. Gulland. The volume is dedicated to this distinguished biochemist, who lost his life a short time after the meeting.

The 25 separate articles can be grouped into five major sections. The first deals with problems of the chemical and physical constitution of nucleic acids (NA) and nucleoproteins (NP). The structure of NA as a polynucleotide is discussed by Gulland in the light of the results of careful titrations. Taylor, Greenstein, and Hollaender report the effect of X-rays on the state of polymerization of NA, and the effect of ionizing radiations on various preparations of nuclear material is investigated by Errera. Enzymatic degradation as a tool of constitution analysis of NA is described by Greenstein, Carter, and Chalkley; and by Schmidt, Cubiles, and Thannhauser. Michaelis deals with the interaction of NA with basic dyes, correlating the spectral properties of the dyes with their degree of polymerization. For various reasons the chemistry of histological reactions has been notoriously neglected, and it is encouraging to find that the same author who in 1902 wrote a textbook that was probably one of the first introductions to the chemistry of histological staining is returning to this field.

Another group of investigators is concerned with the distribution of NA and NP in cells and tissues. Besides his own findings, Davidson includes data of several other authors on the NA content of mammalian tissues and of tissue cultures. Schneider compares the NA content of liver, regenerating liver, and hepatoma, and extends the determinations to separated cell parts like mitochondria and nuclei. Remarkable progress seems to be taking place in elucidating the composition of the chromosome

This is borne out in studies on isolated nuclear components by Mirsky, Pollister, and Ris, and in histochemical studies by Serra, Schultz, and Mazia, Daniel, Hayashi, and Yudowitch. The presence of the Stedmans at the symposium, and their discussion of nonhistone proteins in the chromosome, give hope that a long controversy is on its way toward resolution.

The role of NA and NP in the biology of bacteria is considered by Belozersky and by Chargaff. Boivin presents his results on the production of mutations in colon bacilli by specific desoxyribose-nucleic acids and proceeds to an interesting discussion concerning the purity of his preparations of NA. The effect of chemical mutagens on bacteria is discussed by Witkin.

The possible significance of NA and NP in the embryonic development of organisms receives consideration by Brachet and Thorell. These authors deal with the possible function of NP as organizer and the changes of NA content in differentiating tissues.

An important phase in the current investigation of NA and NP is their relation to virus reproduction and to the synthesis of proteins. This field is covered by Knight, Hydèn, S. S. Cohen, and Spiegelman and Kamen. The papers of the last three authors deserve attention because of their objections to an oversimplified interpretation of the relation of NA content to protein synthesis in cells.

This volume has been a valuable aid to the reviewer in the course of his research on related topics—by the stimulating comparisons suggested in its widely different approaches, by its critical discussions, its reference lists, and its index. The subject selected for discussion and the high standard of contributions make this symposium a worthy continuation of the series. One is inclined to keep the volume near at hand at the laboratory. Swimming in the swift waters of present research on nucleoproteins, one may regard this book as an anchored raft on which to catch one's breath and gain enough distance from the currents to set one's own course.

HEINZ HERRMANN

Yale University

Investigations of human requirements for B-complex vitamins. Max K. Horwitt, Erich Liebert, Oscar Kreisler, and Phyllis Wittman. Washington, D. C.: National Research Council, 1948. Pp. v + 106. (Illustrated.) $1.00.

Because it is costly and difficult to measure man's physiological needs with quantitative precision, few such measurements have been made. There are very few estimates of continuing needs through periods long enough to stabilize body storage at fixed levels. In the present study, which sets a record for length of observation, experimental subjects were kept under controlled conditions for three years.

Detailed studies are reported on 36 men, 21 of them old and 15 young, who were kept on diets containing graded amounts of thiamine and riboflavin. The results are not dramatic but they indicate that 400 micrograms of thiamine is below the minimal daily requirement of inactive men; that the aged are less resistant than the young to restriction of B vitamins, although their optimal requirements do not appear higher; that a restricted intake of thiamine tends to intensify neurologic and psychiatric symptoms of the mentally infirm, but that a very liberal provision of B vitamins has no observable therapeutic value. A metabolic load test is described which promises to be useful clinically in the diagnosis of thiamine deficiency. It comprises mild exercise after oral glucose and immediate determination of lactic and pyruvic acids in the blood.

In epitome, the book reveals a careful, sober study whose value lies as much in its negative as in its positive findings. It illustrates both the possibilities and the difficulties of using the patients of mental hospitals for practical studies in nutrition. The authors, their sponsors, and the authorities of the Elgin State Hospital are to be congratulated for thoroughness and patience in an investigation requiring a high level of cooperation on the part of staff and subjects.

R. R. WILLIAMS

Research Corporation, New York City

Experimental immunochemistry. Elvin A. Kabat and Manfred M. Mayer. Springfield, Ill.: Charles C. Thomas, 1948. Pp. xv + 567. (Illustrated.) $8.75.

This book fills a particular need long felt by many workers not privileged to mature in the laboratories in which the science of immunochemistry was being molded. Drs. Kabat and Mayer, as students of Professor Heidelberger, have been instrumental in the development of this subject. The present book contains, "for the first time, in one place, the scattered techniques which have been developed to fill the needs of immunochemical problems."

In the first part we have the methodology of the antigen-antibody reactions. Here the quantitative immunochemical principles and methods are very clearly expounded and illustrated so that the student can apply these principles by analyzing for himself some of the numerous tables and graphs that have been compiled from the voluminous source literature. The book also serves as a laboratory manual with its many detailed procedures. Hence, from this section alone the book is an excellent accompaniment to an advanced laboratory course in the subject. Part II gives various applications and uses of the quantitative methods, such as assaying serological reagents and using quantitative methods in studying problems of homogeneity and cross reaction. Part III gives instruction in the special methods ranging from Kjeldahl nitrogen and phosphorus estimations to the more specialized physical biochemistry methodolgy. Part IV is a compendium of what might be termed "immunochemical preparations," giving methods for preparing substances of altered specificities, such as phosphorylated proteins, serum proteins and their fractionation, and various types of bacterial antigens. An appendix deals with the usual problems of bleedings, animal injections, glassware calibration, buffers, spectrophotometry, etc.

Experimental immunochemistry should be, therefore, of considerable value to those who work in the basic fields of preparative biochemistry and microbial metabolism

and who are concerned with problems of "purity" and homogeneity of substances. Every section concludes with an ample bibliography, so that the book serves as an excellent guide to the basic literature of immunochemistry.

With due respect to the present controversy over the terms serology, immunochemistry, and immunology, *Experimental immunochemistry* by Drs. Kabat and Mayer is a book every worker in these fields should have.

SANFORD S. ELBERG

University of California, Berkeley

The hormones: physiology, chemistry and applications. (Vol. 1.) Gregory Pincus and Kenneth V. Thimann. (Eds.) New York: Academic Press, 1948. Pp. xi + 886. (Illustrated.) $13.50.

The hormones is a work designed for the serious student of general biochemistry and physiology. This volume and its forthcoming companion are intended to provide a well-organized and critical description of the chemistry, physiology, and applications of the hormones.

We are in this book treated to a "stock-taking," by experts in their respective studies, of the hormones of plants, insects, and invertebrates. There are excellent discussions of the parathyroid and the gastrointestinal hormones, a somewhat less thoroughgoing treatment of the pancreas, and a very good chapter on the recognized hormones of the anterior pituitary. More than 300 of the nearly 800 pages of text are occupied by accounts of the chemistry and metabolism of the various steroid hormones. (The biology of these hormones, as well as those of the pituitary, will be treated in Volume II.)

Two final chapters, by Folley and Malpress, furnish a most competent guide to the labyrinthine ways of mammary gland development and the control of lactation. From the book as a whole and these last chapters in particular, two essentials to rapid progress in endocrinology are made clear. The first is the need for developing accurate and specific methods of assay. The second is the need for pure hormones in amounts adequate for detailed and extensive study. On the whole, this volume sets a high standard and fulfills its purpose. It is well printed and illustrated, and thoroughly indexed, and its 3,441 references will be invaluable to the student. The editors are to be congratulated both upon their selection of contributors and upon the realization of a needed, useful work.

JANE A. RUSSELL and ALFRED E. WILHELMI

Yale University

The chemistry of penicillin. Hans T. Clarke, John R. Johnson, and Sir Robert Robinson. (Editorial Board.) Princeton, N. J.: Princeton Univ. Press; London: Geoffrey Cumberlege, Oxford Univ. Press, 1949. Pp. x + 1094. (Illustrated.) $36.00.

This book records in detail the results of experimental and theoretical studies carried out by a group of American and British chemists, under the joint sponsorship of the U. S. Office of Scientific Research and Development and the Medical Research Council, London, to determine the chemical constitution and structure of penicillin and to devise synthetic methods for its production. The material published was compiled under the auspices of the National Academy of Sciences, Washington, D. C., under contract with the OSRD and is presented under the following 29 chapters: Brief History of the Chemical Study of Penicillin, by Hans T. Clarke, John R. Johnson, and Robert Robinson; The Earlier Investigations relating to 2-Pentenylpenicillin, by E. P. Abraham, W. Baker, W. R. Boon, C. T. Calam, H. C. Carrington, E. Chain, H. W. Florey, G. G. Freeman, R. Robinson, and A. G. Sanders; The Chemistry of n-Amylpenicillin up to December 1943, by A. H. Cook, and I. M. Heilbron; Status of the Research on the Structure of Benzylpenicillin in December 1943, by Robert L. Peck, and Karl Folkers; Isolation and Characterization of the Various Penicillins, by O. Wintersteiner, W. R. Boon, H. C. Carrington, D. W. MacCorquodale, F. H. Stodola, J. L. Wachtel, R. D. Coghill, W. C. Risser, J. E. Philip, and O. Touster; Penillic Acids and Penillamines, by A. H. Cook; Review of Certain Investigations on the Structure of Benzylpenicillin during 1944–1945, by Robert L. Peck, and Karl Folkers; Some Inactivation and Degradation Reactions of Penicillin, by O. Wintersteiner, H. E. Stavely, J. D. Dutcher, and M. S. Spielman; Desthiobenzylpenicillin and Other Hydrogenolysis Products of Benzylpenicillin, by Edward Kaczka, and Karl Folkers; The Thiocyanate Derivative of Benzylpenicillin Methyl Ester, by Vincent du Vigneaud, and Donald B. Melville; The X-Ray Crystallographic Investigation of the Structure of Penicillin, by D. Crowfoot, C. W. Bunn, B. W. Rogers-Low, and A. Turner-Jones; Identification and Crystallography of Penicillins and Related Compounds by X-Ray Diffraction Methods, by G. L. Clark, W. I. Kaye, K. J. Pipenberg, and N. C. Schieltz; Infrared Spectroscopic Studies on the Structure of Penicillin, by H. W. Thompson, R. R. Brattain, H. M. Randall, and R. S. Rasmussen; Other Physical Methods, by R. B. Woodward, A. Neuberger, and N. R. Trenner; The Constitution of Penicillins, by John R. Johnson, Robert B. Woodward, and Robert Robinson; Penicillamine, Its Analogs and Homologs, by Harry M. Crooks; Penilloaldehydes and Penaldic Acids, by Ellis V. Brown; The Penilloic and Penicilloic Acids and Their Derivatives and Analogs, by Ralph Mozingo, and Karl Folkers; Biosynthesis of Penicillins, by Otto K. Behrens; Chemical Modifications of Natural Penicillins, by R. D. Coghill, F. H. Stodola, and J. L. Wachtel; Oxazoles and Oxazolones, by J. W. Cornforth; Attempted Syntheses of Penicillins, by W. E. Bachmann, and M. W. Cronyn; The Condensation of Oxazolones and D-Penicillamine and the Resultant Antibiotic Activity, by V. du Vigneaud, J. L. Wood, and M. E. Wright; Methyl Benzylpseudopenicillinate, by J. H. Hunter, J. W. Hinman, and H. E. Carter; Thiazolidines, by A. H. Cook, and I. M. Heilbron; The Chemistry of β-Lactams, by S. A. Ballard, D. S. Melstrom, and C. W. Smith; The γ-Lactam of Benzylhomopenicilloic Acid and Related Compounds, by Vincent du Vigneaud and Frederick H. Carpenter; Synthetic Benzylpenicillin, by Vincent du Vigneaud, Frederick H. Carpenter, Robert W. Holley, Arthur H. Livermore, and Julian R. Rachele; Assay of Penicillins, by John V. Scudi, and H. B. Woodruff. There is also an appendix and an index.

During the past three years chemists have looked forward with great expectation to the appearance of this monograph, in which for the first time there would be presented in its entirety a description of the work connected with one of the important war projects, namely, the determination of the structure of the antibiotic peni-

cillin, and development of methods for its synthesis. In the opinion of this reviewer, however, there will be many who will be keenly disappointed; for the final chapter has yet to be written. After some 1,042 pages the careful reader is forced to the conclusion that there are still doubts as to the true structure of this highly important compound, and when one considers the detailed description of the experimental studies on synthesis one cannot help but wonder why prior release for publication was given to this phase of the work, and why it was heralded in the public press, especially since the method of synthesis was suggested by the supposedly wrong formula and the yields obtained were practically insignificant. From this point of view the compendium under review will go down in chemical history as a monument to what must be considered a failure. This failure, however, to achieve the objective should by no means reflect upon the efforts of a large group of chemists in American and British Laboratories which resulted in an unusual degree of cooperation.

In certain instances the choice of authors for particular chapters and the stress of their importance in the compendium will appear surprising inasmuch as the selection was supposed to be made on the basis of contributions made, and familiarity with the subject as a whole.

Admittedly, the task of compiling material from hundreds of reports must have been enormous and editing a first-class monograph is necessarily very time-consuming; yet it is disappointing to discover that chapters are often not in sequence and that, whereas in some cases the discussion is incomplete, and consists only of reference to other chapters, in other cases there is a great deal of repetition which easily could have been avoided. Thus Chapter V, which is concerned with the isolation and characterization of the penicillins, would normally be either the first or second chapter. Chapters II, III, IV, and VII, which are separate historical episodes, could well have been combined and condensed into one chapter. Chapters VI, VIII, IX, X, XV, XVI, XVII, XX and XXIV, which are primarily concerned with the reactions of penicillin, certainly should have been better integrated, and possibly combined into two chapters. If this had been done a great amount of material which has little or nothing to do with the structure of pencillin could have been deleted and much space could have been saved. It is also the opinion of this reviewer that the material in Chapters XXI, XXV, XXVI and XXVII, interesting and scientifically valuable as it is, does not justify its separation into four chapters. It is relevant only when considered in connection with degradation and synthetic studies, which are described in other chapters. Chapters XXII, XXIII, XXVIII, and XIX, which deal with the problem of synthesis, could well have been combined and the numerous unsuccessful attempts summarized or tabulated. Chapters XI, XII, XIII, and XIV, which deal with the physicochemical techniques of the structural investigations, are placed for no apparent reason in the middle of the book. They are repetitious and most of the findings should have been reported in their proper place in other chapters.

Certain other features are perhaps unfortunate. Divergent views often appear with different interpretations of the same results. Although the instances are not glaring, they are subtle. The chronological development of the chemistry of penicillin is handled differently by the British and the American authors. In this respect the American authors appear the more disinterested. It is also noteworthy that, whereas American investigators were apparently not allowed to sign their reports, British reports are known under their authors' names.

The index will also give concern to some readers. Although it represents a tremendous task, in some instances it will prove to be unsatisfactory, since the same compounds, reactions, and topics are often scattered throughout the book from cover to cover, and yet only one or two references are given. Names of compounds in the text are not always the same as names in the index, but to those familiar with the field this presents no serious difficulty. Also, for some compounds there are references in the index to experimental sections but no references to the discussion sections, which might be concerned with the explanation. In general, however, the index is workable. Most of its faults result from variations in nomenclature employed by the various authors and by the workers responsible for the work on penicillin.

Finally, there will be some who think that all this material should have been published in learned society journals, in the usual standard manner. Such an opinion deserves respect. Failing this, however, they will say that the format is too large and that the book should have appeared in several volumes. A good argument can be given for this point of view, although this reviewer is inclined to believe that for a reference book the format of the *Journal of the American Chemical Society* is better.

In all other respects the compendium is well prepared. Taken as a whole, the book contains a wealth of knowledge on heterocyclic chemistry, but whether it all belongs in a book on the chemistry of penicillin is debatable. As a reference book, it will be very valuable, especially to those who plan future research work in this field. The book will also be useful for patent purposes. Primary sources are cited, and it is now possible to go to them easily.

Consideration of the shortcomings of this present publication necessitated by the restrictions imposed by Wartime Censorship may afford a lesson for future would-be controllers of scientific thought in times of national emergency.

Special praise and commendation should be given the publishers who were responsible for the design, and manufacture of the book. It is bound with extra strong materials and the printing is excellent. Princeton University Press handles the distribution in the U. S., and Oxford University Press acts as its agent for distribution in England, India, S. Africa, Australia, New Zealand, Pakistan, Burma and Ceylon. Other agents are distributors for the book in Central Europe, Canada, Latin America, the Near and Far East. Thus the desires of the National Academy of Science for International distribution are well met.

The manuscript submitted ran to over 400 pages. The book was set in type chapter by chapter. Early portions of the book were in galley proof before the end was set in type. The double column design adopted was modeled after the Journal of the American Chemical Society on the theory that chemists are familiar with this type of format. The small print for the experimental sections made further compression possible. The size of the book was chosen so that it would fit in the same shelves as the Journal of the American Chemical Society bound volumes. The book weighs five and one-half pounds. The entire cost of publication was borne by Princeton University Press. Dr. Clarke edited the American sections; Sir Robert Robinson edited the British sections and Dr. Johnson was responsible for the Index.

EVERETT S. WALLIS

Princeton, New Jersey

General endocrinology. C. Donnell Turner. Philadelphia-London: W. B. Saunders, 1948. Pp. xii + 604. (Illustrated.) $6.75.

There has long been a need for this book. Most texts on endocrinology have been written to fit the needs of the advanced investigator and physician, with no effort to interest a more general group of readers and afford them a good background and bibliography. This volume will probably do more to stimulate work in the field than many weightier and more specialized tomes.

Turner has fitted many of the arguable points into the first two chapters. His introduction, for example, includes a general survey of backgrounds and methods and the generalized features and glands of uncertain endocrine function. The second chapter is mainly centered about the biology of secretion, and here we find some strange companions such as chemical coordinators, inductors, and evocators (embryonic), phytohormones, chemical mediators (nervous), autolyzing tissues, parahormonics, and vitamins. The space devoted to these components is not great and serves to advantage in bringing diverse phenomena together even though they cannot all be catalogued as cell secretions. The accent of the chapter is directly on the physiology of the secretion and if occasionally substances which are normally cell bound are included under this head, it is of advantage to notice the analogies of functional condition which may pervade the reactions of the products.

The succeeding chapters from three through twelve deal in the main with individual glands in as complete a manner as is possible in a work of this size. There are excellent bibliographies at the end of each chapter, giving a sequence to the total work performed in organizing the information presented. In Chapter VI, succeeding that treating the pancreas, there is a short and succinct treatment of the alimentary secretions and their relation to the generalized picture of reaction.

Chapter XI is taken up completely with the interaction of the hormones during pregnancy and lactation and an excellent review of what we know about the interacting constituents during these processes.

After a concise treatment of the hypophysis (pituitary) the last 75 pages of text are devoted to a review of endocrine mechanisms in the invertebrates. This is an admirable presentation of the diverse mechanisms and how they work. While one might argue about some of the implied correlations between the activity of vertebrate and invertebrate materials, this in no way detracts from the presentation as a whole. The fact that it is presented in arguable form is a compliment to the ingenuity of the author, for these reacting substances do not have the clarity of result or the known chemistry of the vertebrate secretions.

The book as a whole is informative, carefully prepared, and extremely intriguing. It is a unique treatment of this very interesting field.

J. S. NICHOLAS

Yale University

Pathology. W. A. D. Anderson. (Ed.) St. Louis, Mo.: C. V. Mosby, 1948. Pp. xii + 1453. (Illustrated.) $15.00.

This book is not just another textbook of general pathology. Neither does its virtue lie in any unique manner of presenting its subject, since it follows in general the standardized order, with chapters on the fundamental pathological processes, their variations with etiology, and their manifestations as related to the various parts of the body. The text will have outstanding value for teachers and graduate students of pathology, who will find therein an unusual amount of useful information ordinarily gleaned only by extensive search through periodical literature.

Most of the chapters are written by well-known authorities in the various fields, who have carefully evaluated data from many sources, and have recorded the salient facts in concise, convenient form. The use of headings, spacing, varied printing, and numerous illustrations gives emphasis to the more important subjects and facilitates ready reference. Each chapter is concluded with a generous bibliography, arranged conveniently according to subjects. Most authors have placed commendable emphasis upon relationships between pathology and the other basic sciences, and between pathological changes and clinical phenomena.

The changing order in our modern world justifies the

attention directed at the formerly designated "tropical diseases," and to the effects of various forms of radiation upon tissues. Also treated comprehensively are the diseases of the skin, special sense organs, lips, mouth, teeth, and skeletal system. A surprising omission is a chapter on diseases of muscles. This is especially disappointing since a growing interest in this subject is increasing the number of muscle biopsies to be diagnosed by pathologists.

As a textbook, this book will create by its bulk a real problem for medical students who are expected to assimilate it in the usual one-semester course. As a reference book, it can be recommended unreservedly to all who are interested in the problems of disease.

PEARL M. ZEEK

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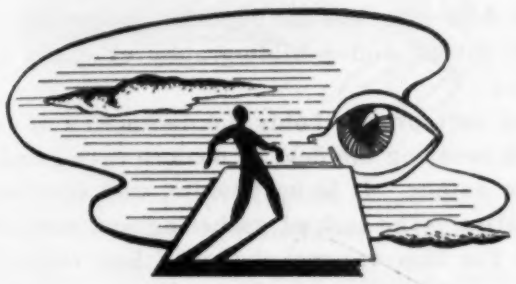


Psychiatry in general practice. Melvin W. Thorner. Philadelphia-London: W. B. Saunders, 1948. Pp. xi + 659. $8.00.

The author of this book has attempted to present psychiatry in a language relatively free of confusing terminology, and yet he manages to cover the theories and concepts that are generally accepted today.

The book is divided into two main parts, which are designated as "The People" and "The Methods." In the first part the chapters are named by the principal problem or mental symptom, e.g., "Intelligent People," "Dull People," "People and Sex," "People and Catastrophe," "Unhappy People," "Dreamy People," "Confused People," "Anxious People." One might raise the objection that such titles detract from the dignity of the book. Each chapter has a short informative introduction to the topic, complete illustrative life histories of patients, and an excellent summary. The author hopes to give the student or physician the "feel" of the psychiatric patient and his use of many well-selected case records and brief interpretations of the patients' behavior does much to accomplish this purpose.

Treatment is the theme of the second part of the book. There are good chapters on interviewing, sedation, and psychotherapy. The limitations of such procedures as electroshock therapy and prefrontal lobotomy are discussed. The information about the related shock therapies is concise but adequate to enable the physician to discuss with the family the nature of a treatment that may have been recommended by a psychiatrist or hospital.

This book offers much help to the general practitioner in understanding and treating many of his patients. It is recommended.

FRANK H. LUTON
Vanderbilt University School of Medicine

The aviation psychology program in the Army Air Forces. (Rep. No. 1.) John C. Flanagan. (Ed.) Washington, D. C.: Supt. of Documents, U. S. Govt. Prntng. Office, 1948. Pp. xii + 316. $2.00.

This is the first of a series of 19 volumes designed to record, evaluate, and make available the major research findings and experience of the AAF Psychology Program during the period of World War II. In this volume, Col. Flanagan, who directed the program under the Air Surgeon, Major General David N. W. Grant, and the chief of the Medical Research Division, Col. Loyd E. Griffis, reviews the research findings and discusses their implications. The book is both an introduction and a summary of the series; the titles and editing authors of all 18 volumes of the series are listed on pages 3 and 4. So much credit is given to his military and civilian associates that Col. Flanagan's own outstanding contributions as director and research leader of the program are not immediately evident. The volume is arranged in three parts: I. Background and development of the Aviation Psychology Program; II. Specific solutions of problems; and III. General contributions.

Building on the experience of World War I and on some work accomplished by civilians through the National Research Council and the Civil Aeronautics Administration in 1939 and 1940, the Army program took shape. It was decided to organize a coordinated research program rather than a strongly centralized agency, and to place the work in intimate association with the AAF training fields. Twenty categories were identified by analyzing the reasons for eliminating men from primary flight training. These were grouped into four principal areas for assigning responsibility for test development: (1) tests of information, judgment, and intellectual ability, (2) tests of alertness, observation, and speed of perception, (3) tests of coordination and visual-motor skill, and (4) tests of personality, temperament, and interest. Previous efforts had centered chiefly on selection of pilots. The AAF program envisaged a broader need, that is, the selection and classification of all air-crew.

There are five fundamental steps that psychologists use in aptitude testing and personnel selection: I. *Job analysis* of positions for which applicants are to be selected; II. *Test construction* in line with the job analysis by adapting previously used tests or in making up new ones; III. *Test reliability determination* through giving alternate forms to sample populations and noting degree of score agreement; IV. *Rehearsal administration* of proposed tests to training groups otherwise selected for discovering the relation of test scores to success and failure in training; and V. *Validation appraisal* through selecting men for training by the tests developed; then after training or other exhibits of compe-

tence in job performance relating the test scores to the success or failure records, and finally discarding those tests which have proved low in prediction value. In the Air Force program several hundred tests were worked through these five steps and only the best twenty or so were used in the final selection batteries. There were two main groups of tests used: (1) The AAF Qualifying Examination (in place of the earlier requirement of two years of college), which was given to more than a million men, and (2) Special Abilities, given to more than a half million in making selections for bombardier, flight engineer, navigator or pilot training.

It is interesting and illustrative of the material presented in Col. Flanagan's Report to note (pp. 82 ff.) that when step IV was applied to more than 1,000 men assigned to pilot preflight schools only 23 percent succeeded in becoming rated pilots, whereas if only the upper half had been admitted, as rated by their scores on the tests being tried out, 75 percent, on the same criteria, would have been rated successful. When the matured selective techniques were used the failure rate dropped so low that fewer training fields were required.

The aviation psychologists were able to develop objective measures of flying skill, aerial measures of navigation proficiency, rating methods for flexible gunnery, and proficiency tests for flight engineers, bombardiers, and radar observers. Their success in screening and selection proved so valuable that they were set to work on the content of training courses and methods of training, and the development of new training devices and equipment. Finally, in the latter part of the war, they initiated a number of testing methods and procedures concerned with individual reactions to combat. As an illustration of the important role that social science can play in human affairs, and of scientific method in social science, this introductory-summary volume and the series of reports it represents may be strongly recommended. Considered from the standpoint of variety of measurements, types of tests, and size of test samples and populations examined, these data from the AAF Psychology Program constitute the largest mass of psychological measurement materials ever gathered in any experimental or applied psychological project. This report and later volumes in the series will long retain their importance in the field of aviation psychology.

Yale University W. R. MILES

General cartography. (2nd ed.) Erwin Raisz. New York-London: McGraw-Hill, 1948. Pp. xv + 354. (Illustrated.) $6.00.

General cartography is a thoroughly revised edition of the book which appeared a decade ago under the same title. It contains a wealth of valuable information and will become one of the indispensable reference books of the cartographer's library.

The quickest way to obtain an idea of the scope of the book is to examine its table of contents: I—The History of Maps, II—Scales and Projections, III—Representation of the Earth's Pattern on Maps, IV—Lettering, Composition and Drafting of Maps, V—Surveying on the ground and from the air, VI—Official and Professional Maps, VII—Cartographic Specialities, VIII—Scientific Maps.

Each of the eight parts listed is composed of four chapters, making 32 in all. This division of the text makes the volume readily adaptable to use in a majority of college courses. There is also an appendix offering instructions for preserving and cataloguing maps, laboratory and field exercises for student assignment, a series of useful tables, and a bibliography of easily available references.

General cartography holds the distinction of being the only book covering the field of modern cartography by an American author. It is up to date, well illustrated, and authoritative. The task of gathering and assembling the material for this volume obviously has required many years of careful research. The finished work is a credit to the author.

As might be expected in view of Dr. Raisz's extensive study of the history of maps, the book contains an excellent treatment of early map making. With the aid of four fully annotated time charts, the author traces the history of cartography from 600 B. C. down to the present. The reader will find descriptions and illustrations of the charts of the Marshall Islanders, the clay tablet maps of the Babylonians, and the early maps of the Greek, Egyptian, Chinese, and Roman cartographers, including the Ptolemy maps and portolan charts. The achievements of the Dutch, French, German, English and Italian cartographers, the work of the National Surveys, and the growth of American cartography are all fully reported. The four chapters dealing with the history of maps are valuable reading for all cartographers.

The main body of the text is devoted to methods and techniques employed in modern cartography. Unfortunately the author has attempted to cover everything and consequently has failed to give adequate attention to many of the basic elements of the subject. This situation is understandable when one realizes the magnitude of the assignment but it is nevertheless regrettable. Important topics such as relief presentation, map composition, map reproduction, and projections are treated briefly. In the opinion of the reviewer the book would serve more effectively as a text if it gave more attention to how to plan and execute cartographic jobs and less attention to what has been done in the field and by whom. Every page contains interesting and useful information, but much of this is not directly applicable to teaching the subject.

No review of Dr. Raisz's latest book would be complete without mention of the chapters dealing with the application of cartographic and related techniques to the presentation of statistical information. Many excellent methods of putting life into inert masses of figures have been described and illustrated. Statisticians, economists, and geographers will do well to study these chapters carefully.

General cartography is the work of a scientist and artist. It is a contribution to the subject of cartography and will play an important role in the development of the science.

WALLACE W. ATWOOD, JR.

Research and Development Board

Sedimentary rocks. F. J. Pettijohn. New York: Harper, 1949. Pp. xv + 526. (Illustrated.) $7.50.

Sedimentary rocks, by F. J. Pettijohn, comes at an opportune time, 10 years after the last comprehensive volume on sedimentation was published by Twenhofel. Pettijohn's treatise is essentially a study of the products of sedimentation rather than its processes. The book begins by summarizing the general nature of sedimentary rocks and discussing their principal attributes: texture, mineral and chemical composition, structure, and color. A chapter on classification follows, and then the principal types of sedimentary rocks are described in considerable detail. The work concludes with a discussion of the processes of weathering, transportation, deposition, and diagenesis.

The general approach is well balanced and attention is focused on the more important aspects of sedimentation. Minor controversial features are dismissed with brief discussions or reference to pertinent literature. The 700 citations to previous literature are well chosen and up to date. Pettijohn's general appraisal of other authors' work is good, but he places more reliance on the validity of some inferences he cites than this reviewer would. The volume contains many tables on the chemical and mineralogical composition of sedimentary rocks. The illustrations are well chosen and include many graphs showing quantitative relationships of properties of sediments to one another. The index is moderately good.

This book is so worthwhile that any attempt to point out its weak parts is likely to overemphasize them with respect to the work as a whole. The discussion of black shale, ocean and lacustrine deposits, and the fundamental physical and chemical processes affecting sediments seems to be less effectively treated than other subjects; but on the other hand the discussion of glacial sediments, abrasion of particles, quantitative aspects of sedimentation, and applications of laboratory studies to the interpretation of sediments is extremely stimulating. The section on geosynclinal sedimentation is particularly interesting.

Pettijohn has proposed a new classification of sedimentary rocks, partly descriptive and partly genetic. Geologists may have mixed feeling over some of the names that are recommended. For example, to call a quartzose sandstone an "orthoquartzite" is likely to cause confusion, because of the well-established usage of the term "quartzite" in metamorphic geology. On the other hand, the designation of the term "graywacke" for an indurated feldspathic sand with a clay or chlorite matrix seems quite useful.

This volume, according to the author, is designed as a text for senior and graduate students. It is also a handy book for the mature worker and altogether represents a distinct contribution to geology.

PARKER D. TRASK

Oakland, California

Geology and paleontology. (Fiat Review of German Science, 1939–1946.) Ludwig Rüger, et al. Berlin: Office of Military Government for Germany, 1948. Pp. 246. (Illustrated.)

This volume is one of a series which, in the words of its sponsors, is intended to "present a complete and concise account of the investigations and advances of a fundamental scientific nature made by German scientists in the fields of biology, chemistry, mathematics, medicine, physics and sciences of the earth during the period May 1939 to May 1946." The series will include reviews of work on 44 subjects within these fields; some subjects, such as inorganic chemistry and applied mathematics, require five or six volumes.

Besides the present volume, the earth sciences are represented in the series by four volumes devoted to geography, one to mineralogy, and two to petrography.

The following have contributed reviews to Part I of the work (general geology): L. Rüger (geologic chronology; interior of the earth, vulcanism); D. Schaehner-Korn (structural geology); K. H. Scheumann (petrotectonics of the Variscan and pre-Variscan crystallines on the northern border of the Bohemian Massif and in the Sudeten); A. Strigel (tectogenesis of the European and North African Variscan [Hercynian]); W. Carle (post-Variscan tectonics in central Europe); A. Bentz (salt domes, petroleum geology); W. Schott (recent deep-sea sediments); E. Stach (coal petrography); E. Blanck (weathering); and H. E. Stremme (soil science).

To Part II (formations) the following contributed: M. Schwarzbach (Cambrian); G. Solle (Devonian); A. Strigel (Carboniferous, Permian); W. Schott (Triassic, Weissjura); K. Hoffmann (Lias and Dogger); O. Seitz (Cretaceous); A. Schad (Tertiary of northwest Germany); E. Wirth (Tertiary of the upper Rhine Valley); and E. Ebers (Quaternary geology of the Northern Alps).

The third and last section, paleontology, is constituted as follows: H. Hiltermann (micropaleontology); M.

Schwarzbach (sponges, corals, brachiopods); H. Sieverts-Doreck (echinoderms); H. Schmidt (palaeoammonoids); F. von Huene (fossil vertebrates).

As is almost inevitable in such an undertaking, the reviews differ greatly in degree of detail. In part this is a valid reflection of the times; the section on salt domes (nine pages plus a map), while disproportionately long at first glance, is an obvious result of the wartime search for oil. Stress on practical applications of soil science and upon soil-mapping techniques is in part a result of the war; in addition, there is great interest in detailed investigations of soil genesis.

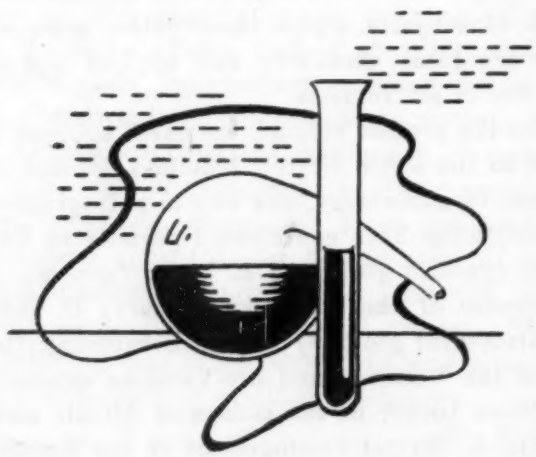
Work in petrofabrics and tectonics has occupied its usual conspicuous position in German geology, as evinced by extended treatment of the subject in general and its application to various regions. Paleontology has not fared so well.

Each section of the volume is accompanied by a bibliography. These are extensive and will be most useful.

The contributors and subjects are listed here because the present edition is a limited one, for government distribution (inquiry should be made to Office of Military Government for Germany [U.S.], Economics Division, Research Control Branch, U. S. Army, APO 742, Berlin). The manuscript for the volume has been turned over to a committee of German scientists for reprinting and perhaps wider distribution. It is hoped that this will be possible. The Office of Military Government is to be congratulated for sponsoring such a valuable synthesis.

FRANK C. WHITMORE, JR.

U. S. Geological Survey



Aquametry: application of the Karl Fischer reagent to quantitative analyses involving water. John Mitchell, Jr., and Donald Milton Smith. New York: Interscience, 1948. Pp. xi + 444. (Illustrated.) $8.00.

This book, Volume 5 of a series of monographs on analytical chemistry and its applications, brings together for the first time everything that has been published on the theory and use of the Karl Fischer reagent. Written by the two outstanding investigators in this field of chemical analysis, it will serve those who are already experienced in the use of the Karl Fischer reagent as well as those who are beginning to use it for the first time. It is well organized and clearly written.

The book was not intended to be a comprehensive treatise on all the methods for the determination of water. But the authors have given a brief and thorough review in the first chapter of the various techniques already published.

Part I deals with the specific quantitative determination of water by Karl Fischer reagent, and an early chapter presents an orderly summary of the directions for preparing and standardizing the reagents. All of the procedures which make use of the reagent are given here and this part of the book will serve as a convenient laboratory manual.

The nature of the chemical reactions involved are thoroughly discussed, with much quantitative data never before published. A chapter is devoted to the various titrimetric procedures, both macro and micro, that have been found useful. The determination of water in various organic compounds, in commercial organic materials and in inorganic compounds is then considered. The final chapter of Part I is concerned with the spurious reactions of Karl Fischer reagent with inorganic compounds which must be guarded against.

Part II presents various applications of Karl Fischer reagent to those types of organic reactions where water is liberated or consumed. Methods are given for the quantitative determination of the following organic functional groups: alcoholic hydroxyl, carboxylic acids, acid anhydrides, carbonyl compounds, amines and nitriles, peroxides, and a few miscellaneous organic compounds.

The final chapter discusses some proposed further studies involving Karl Fischer reagent, such as possible modified reagents, applications to organic reactions which interfere with the present reagent, and quantitative determination of inorganic compounds.

GRANT WERNIMONT

Eastman Kodak Company,
Rochester, New York

Principles of high-polymer theory and practice. Alois J. Schmidt and Charles A. Marlies. New York-London: McGraw-Hill, 1948. Pp. xii + 743. (Illustrated.) $7.50.

Most books on this subject are too specialized to give the uninitiate a broad, clear picture of the nature and behavior of high polymers. Again, most authors are so preoccupied with describing the characteristics of specific materials that they too frequently overlook the fundamental principles underlying all high polymers. As a result such books are of interest primarily to those engaged in special fields of high-polymer chemistry, physics, or engineering, and are not particularly suitable for use as textbooks.

The authors' aims in writing this textbook on the *principles* of high-polymer theory and practice have been to avoid shortcomings such as these, "to present a broad, coordinated treatment of a field in which about one-third of all American chemists and chemical engineers are currently employed," and to demonstrate "how fundamentals of physics, chemistry, and engineering may be applied universally to the materials in question." As

a result, stress has been placed not only on purely chemical aspects of the subject, but also on physico-chemical, rheological, and structural principles underlying high polymers, their properties, and their applications.

The contents of the book may be judged from the chapter headings: 1. Introductory Definitions and Concepts; 2. Molecular Forces; 3. Some Special Behaviors and Properties of High Polymers; 4. Polymer Formation and Modification; 5. Structures of High Polymers; (6) Solubility and Molecular Weight Relations; 7. Rheology; 8. Molding and Manipulation; 9. Mechanical Properties; 10. Electrical, Thermal, and Optical Properties; 11. Fibers and Fibrous Products; 12 and 13. Rubbers; 14. Surface Coatings; 15. Adhesive; 16. Resin Product Development. The book also includes an appendix section on high-polymer literature; properties of various fibers, plastics, and rubbers; adhesion, compatibility, and solubility of sundry materials of interest; and a table of chemical formulas and trade names of high polymers. The combined author and subject index covers 28 pages.

In their presentation the authors have treated briefly some topics which could stand fuller development, or have oversimplified the presentation in some instances for the sake of generalization. However, in a book of this type such a procedure is unavoidable. In the reviewer's opinion the authors have well attained their stated aims, and they have performed a real service in reducing to fundamentals the multitudinous aspects of high-polymer theory and practice. The book should prove well suited as a text for a good course in high-polymer principles, as well as a stimulating and valuable reference on the shelf of persons interested in high polymers.

The present volume has been published as part of the McGraw-Hill *Chemical Engineering Series*. The reviewer considers this classification misleading. Although it was written by teachers of chemical engineering, the book throughout reflects a broad and fundamental, rather than an engineering, approach to the subject, and it should have, therefore, a much wider field of interest than its classification would suggest.

SAMUEL H. MARON

Case Institute of Technology

Diagnostic techniques for soils and crops: their value and use in estimating the fertility status of soils and nutritional requirements of crops. Herminie Broedel Kitchen. (Ed.) Washington 6, D. C.: American Potash Institute, 1948. Pp. xxiii + 308. (Illustrated.) $2.00.

This volume, sponsored by the American Potash Institute, consists of a historical introduction by Firman E. Bear and contributions by eleven other agricultural scientists, all assembled under the editorial guidance of Herminie Broedel Kitchen. It brings together the most recent methods for the testing of soils and plants for their content of several nutrient elements. Even though most of the material has previously been published in various journals, its assembly into a single volume represents a helpful service. It is testimony of increased attention to the possible chemical interactions by which soil nourishes plants.

The chemical methods for assessing soil fertility are clearly presented. These details will be very helpful to the student of soil chemistry and plant nutrition. The discussion of the correlation of soil tests with crop responses to fertilizer treatments, by R. H. Bray, is not only interesting but very enlightening. It accentuates the need for more information of this type, especially when commercial nitrogen and trace elements are moving into more general use. Such information is leading the agronomist, and anyone concerned with crop production, to look more to the soil in place, and not only to the crop and the soil in general.

The details of mass testing myriads of soil samples in a state or industrial laboratory appear less valuable. One is reminded that assembling data of multiplied cases on state dimensions has less virtue than educating individual farmers and county agricultural advisors by means of a few tests on specific soils whose history is a personal or lifetime experience.

The entire volume is well justified by the contribution discussing the testing of plant tissues in relation to their visual symptoms of malnutrition. This is excellent reference material. There is in this the starting point for diagnostic reasoning going from the visual symptoms of the growing plants to their deficiencies in nutrient chemical elements as parts in the plants' synthetic performances, and from there to their supply in readily exchangeable form in the soil.

The discussion of the biological assays of soil fertility omits those which have been superseded by rapid chemical methods. It develops new assays fitting the instances where chemistry is difficult or inadequate. Through the biological assays the symptoms of the plants are tabulated in greater detail in relation to the levels of nutrition as fertility of the soil. It is these symptoms that prompt their diagnosis as related to irregularities in the soil growing the crop.

The service this volume performs is its encouragement and help toward more careful observation of the plants as they reflect the nutritional services of the soil growing them. It will help to increase critical observations by the farmers themselves. The fact that enough differences in growth behavior of plants have been observed to challenge our diagnosis of the plants' physiological irregularities provoking them draws attention to the recent progress in both plant and soil sciences by which plant functions are causally connected with the chemical dynamics only recently elucidated for the soil. It is a gratifying record of these two sciences that soils and crops are becoming more closely linked in our understanding of plant growth as the creation of the living organic from the lifeless inorganic; it is also gratifying that a volume like this should help us view growth performances by the plant as those in which irregularities submit to diagnosis via procedures no different in principle from

those explaining the irregularities in physiology and nutrition of animals and man.

E. R. GRAHAM and WM. A. ALBRECHT
University of Missouri

Rings and ideals. Neal H. McCoy. (Carus Mathematical Monographs of The Mathematical Association of America.) LaSalle, Ill.: Open Court Publ., 1948. Pp. xii + 216. $2.00.

This attractive little volume, well written and neatly printed, offers an excellent and almost entirely self-contained introduction to some of the most interesting topics in elementary modern algebra. Chapter I discusses the idea of a ring, with the help of some carefully thought out examples; chapter II further illustrates the same concept by a more detailed discussion of polynomial rings. Chapter III introduces the all-important notions of the ideal, of homomorphism, and of the residue class ring. After some auxiliary results in chapter IV, chapters V and VI offer an excellent, thoroughly modern, and lucid treatment, by means of Zorn's principle (without any finiteness assumptions), of the basic properties of the radical and of the Jacobson radical, and their application to the representation of rings as direct or subdirect sums. This is illustrated, in chapter VII, by a discussion of Boolean rings and of p-rings. The last two chapters (somewhat loosely connected with the rest of the book) give a concise exposition of matrices and determinants over arbitrary commutative rings (knowledge of the theory of determinants over a field being assumed), and of the basic facts concerning primary ideals and Noetherian rings.

Utmost simplicity has been reached in nearly all proofs; this, together with an easy and readable style, and a skillful use of examples, should put the book well within reach of beginners in the field, without rigor being sacrificed in any way to this object. Both the simplicity of the exposition and the generality of the results are further enhanced by the fact that the author carefully avoids bringing in any assumption before it really becomes necessary; when he does so, he takes into account the results of the latest research, including some of his own. Thus, chain-conditions are not even mentioned before the last chapter. Similarly, commutativity is introduced only when it is needed, even though the emphasis is mostly on commutative problems and methods. All this is in full agreement with the lastest developments in algebraic theory and practice, and should prove most helpful to readers who wish to acquaint themselves with such developments; further help and guidance is provided by means of a good bibliography and a brief discussion of the main source material at the end of each chapter.

The author deserves to be congratulated for this valuable addition to the literature; and the book may be warmly commended, both to newcomers to the subject and to those who have lost contact with it and may wish to bring their knowledge of its basic principles up to date.

ANDRÉ WEIL
University of Chicago

Introduction to applied mathematics. Francis D. Murnaghan. New York: John Wiley; London: Chapman & Hall, 1948. Pp. ix + 389. $5.00.

This is a time when applied mathematics is being cultivated very vigorously. Problems of gas dynamics, elasticity, atomic physics, and nonlinear mechanics, to name but a few fields, require the most powerful and advanced tools available to the mathematician, physicist, or engineer. Coincidentally, there is a need for books which will present in a clear, connected, and reasonably complete fashion the known facts about eigenvalue problems, partial differential equations, integral equations, calculus of variations, etc. Prof. Murnaghan, who has done outstanding work in applied mathematics, has drawn on his twenty years' experience in presenting such material to graduate students and has written a good and helpful introduction to the field.

The first two chapters are devoted to vectors and matrices. The treatment is vigorous and proceeds from the special to the general, a plan followed wherever possible throughout the book. Included are n-dimensional complex space and an introduction to the eigenvalue problem. Chapter 3, one of the most important, carries the discussion into function space; here the student will find orthonormal sets of functions, generalized Fourier expansions, and linear integral operators. Chapters 4 and 5 discuss curvilinear coordinates and Laplace's equation. Considerable attention is paid in the latter chapter to the useful "method of images." Chapter 6 discusses separation of variables for partial differential equations, power-series methods for ordinary differential equations, and special functions. In Chapter 7, the student will find self-adjoint linear differential operators, boundary conditions of various types, and a very complete discussion of Green's functions—including the central theorem concerning the equivalence of linear second-order boundary-value problems and Fredholm integral equations. Chapter 8 gives the theory of Fredholm integral equations and concludes with a careful discussion of Rayleigh's principle. Chapter 9 discusses the calculus of variations, with applications to dynamics. The last chapter is devoted to operational calculus, based on the unilateral Laplace transformation. The discussion is restricted to ordinary differential equations of general order and systems of such, but these are treated completely.

Altogether, the reviewer considers this a good though demanding introduction to applied mathematics. The word *introduction* is to be emphasized; in its 389 pages, the author has been forced to omit mention of several important topics, notably initial value problems. However, there are good discussions elsewhere of most of the omitted questions—while of the topics included, there are

several for which no careful treatment at the beginning graduate level has been available previously. The typography is excellent (boldface and italics are used freely), and there are numerous exercises, many of which serve to amplify and extend the text. All through the book there are informal notes, cautions, and pointed queries, which serve the double purpose of easing the sometimes heavy going and of keeping the reader alert.

A. WEINSTEIN

U. S. Naval Ordnance Laboratory

Functional analysis and semi-groups. Einar Hille. (American Mathematical Society Colloquium Publications, Vol. XXXI.) New York: American Mathematical Soc., 1948. Pp. xi + 528. $7.50.

A semigroup is an associative (but not necessarily commutative) multiplicative system. It is more general than a group because neither the existence of the unit element (and *a fortiori* of the inverse element) nor the rule of cancellation (rule of division) is assumed. This book is devoted to the study of such systems and their representation by linear operators in a Hilbert or a Banach space (for example, a one-parameter semigroup of operators T_t, $t > 0$, which satisfy $T_s T_t = T_{s+t}$ for any positive s and t).

Investigation of semigroups and their representations is not only interesting as a mathematical theory by itself (Laplace transforms and binomial series, Fourier series and integrals, summability and Tauberian theorems, operator calculus and spectral theory), but it is also important in view of its application to probability and statistical mechanics where the notion of irreversibility and tendency toward equilibrium comes into question (ergodic theory, Markoff processes, stochastic processes, diffusion problem, conduction of heat, and related partial differential equations).

The book consists of three parts and an appendix. The first part, which is a preparation for the rest of the book, is itself a self-contained, up-to-date introduction to the theory of functional spaces. Part II develops an analytical theory of general semigroups and their representations, which is applied in Part III to special cases to obtain important results concerning groups and their representations in a unified way. The book also contains many interesting results of the author which have not been published elsewhere.

The appendix is an exposition of the theory of Banach algebras (normed rings), a field which promises to become one of the main centers of mathematical interest. Here the stress is shifted to the algebraical aspects of the problem, while in the main body of the book emphasis is always placed on the analysis. Readers who have witnessed the achievements of topological and operational methods in functional analysis (differential and integral equations, theory of Hilbert and Banach spaces) will find the recent success of the algebraic method (as in the case of Tauberian theorems) very interesting. Professor Hille's book constitutes an important addition to mathematical literature, coming as it does at a moment when systematic rearrangement and clear exposition of the various results of this already large and ever-growing subject seem to be necessary for the purpose of stimulating further progress in research.

SHIZUO KAKUTANI

Institute for Advanced Study

Theory of equations. J. V. Uspensky. New York-London: McGraw-Hill, 1948. Pp. vii + 353. $4.50.

The late Prof. Uspensky's new volume will be welcomed by all who teach or use the theory of equations. It is considerably longer than the well-known texts of Profs. Dickson, Weisner, and J. M. Thomas, and presents a wealth of ideas in easily available form.

The discussion of the numerical solution of real polynomial equations is masterly, and includes valuable appendices on Routh's rule, iterative methods, Graeffe's method, and a new method for separating roots (Vincent's method). This discussion will make the book a valuable text and reference book for engineers.

On the other hand, no flavor of the modern abstract point of view is given: thus "fields" of complex numbers are nowhere defined, and matrices are treated after determinants. Moreover, the classical prescription offered for solving simultaneous linear equations by Cramer's Rule (determinants), however elegant theoretically, is notoriously ineffective. For these reasons, many teachers will wish to use the book not as a basic text but as a supplementary text or reference. It should be nearly indispensable for that purpose.

GARRETT BIRKHOFF

Harvard University

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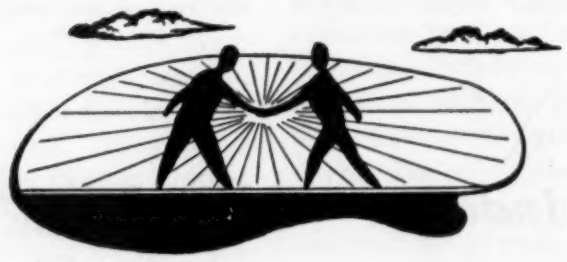

Association Affairs

The Southwestern Division of the AAAS will hold its 25th meeting in Alpine, Texas on May 1–5, under the presidency of R. A. Studhalter, of the Department of Biology of the Texas Technological College. Host institutions are the Sul Ross State Teachers College and the McDonald Observatory on Mt. Locke near Ft. Davis. Alpine, a frontier town of 6,000 population, is the home of Sul Ross State College. It is located on the Southern Pacific and Santa Fe Railroads at an altitude of approximately 4,500 feet. Highway 90 leads through Alpine from San Antonio to El Paso; highway 118 joins Alpine and Ft. Davis. The general area is that of the cattle kingdom of Texas.

McDonald Observatory, a branch of the Yerkes Observatory, is operated jointly by the University of Chicago and the University of Texas. It is located 15 miles northwest of Ft. Davis on a paved highway. Ft. Davis was established as a frontier outpost prior to the Civil War, and was abandoned as a military post when the Davis Mountain area no longer held a threat of Indian attack. Ruins of the old fort, some now in process of reconstruction, are of considerable interest.

Ojinaga, Mexico, just across the Rio Grande from Presidio, Texas, will be the destination of an excursion on Tuesday afternoon and evening. Ojinaga is a typical Mexican town and entirely representative of the rural areas of Old Mexico.

The annual Powell Lecture is to be delivered by John Charles Kelley, assistant professor and curator of anthropology at the University of Texas Museum. He is regarded as an authority on the archaeology of the Texas Indians. The general program will be enriched by the participation of a number of Mexican and Texan organizations, including the Sociedad Chihuahuense de Estudios Históricos, the Texas Academy of Science, the Texas Archaeological and Paleontological Society, and the West Texas Historical and Scientific Society.

The section meetings will close on Wednesday and there will be an all-day excursion to the Big Bend National Park on Thursday. The local group, under the chairmanship of G. Preston Smith, dean of the Sul Ross State College, has spared no effort to make the meeting a great success. It is hoped that the attendance will be large, in order to assure the local host institutions that their efforts have not been wasted.

FRANK E. E. GERMANN

General Program

Sunday, May 1, 1949. 3:00 p.m.: Meeting of the executive committee, Southwest Division, Room 217, Main Building, Sul Ross College. *8:00 p.m.*: Open House, McDonald Observatory.

Monday, May 2, 1949. 8:30–9:45 a.m.: Registration, Library Building, Sul Ross College. Registration continues through Wednesday. *10:00–12:00 a.m.*: General Session, Sul Ross Auditorium. Music—Glenn Davis, head of the Music Department, Sul Ross State College, directing. Address of welcome—R. M. Hawkins, president, Sul Ross State College. Response—R. A. Studhalter, president of Southwestern Division. Address—Gerard P. Kuiper, director of Yerkes and McDonald Observatories. *1:30–3:30 p.m.*: Section meetings. *3:45–5:00 p.m.*: "Ten Years of Astronomical Observation at McDonald Observatory," Gerard P. Kuiper, Sul Ross Auditorium. *5:00–6:00 p.m.*: Open House, Museum of West Texas Historical and Scientific Society. *8:00 p.m.*: John Wesley Powell Lecture, John Charles Kelley, assistant professor of anthropology and curator of the Anthropology Museum, University of Texas, Auditorium, Sul Ross College. (The public is cordially invited.)

Tuesday, May 3, 1949. 7:30 a.m.: Breakfast, Sigma Xi. Place to be announced. *8:30–10:00 a.m.*: Section meetings. *10:00–12:00 a.m.*: Report from McDonald Observatory, Sul Ross Auditorium. *1:00 p.m.*: Luncheon, complimenting visiting ladies, Indian Lodge. *1:00–3:30 p.m.*: Meeting of the Texas Archaeological and Paleontological Society, Col. M. L. Crimmins, U. S. Army, retired, presiding, at the Auditorium, Education Building. *3:30–10:30 p.m.*: Tour to Ojinaga, Mexico, including dinner, Roof Garden, Rohana Hotel, Ojinaga.

Wednesday, May 4, 1949. 7:30 a.m.: Breakfast, Phi Delta Kappa. Place to be announced. *8:30–11:00 a.m.*: Meeting of the Texas Academy of Science, Sul Ross Auditorium. C. M. Pomerat, professor of cytology, Medical Branch, University of Texas, Galveston, Texas, presiding. *11:10–12:00 a.m.*: Address by President J. Brian Eby of the Academy, "Geophysics and Geology in Oil Exploration," Sul Ross Auditorium. *1:30–3:00 p.m.*: Section meetings. *3:00–4:00 p.m.*: Movie film (partly kodachrome) taken during World War II in Nigeria and the African Gold Coast of leper colonies, market places, disk-lip people of the interior, a boat trip on Lake Alo (part of old Lake Tchad), a boat trip on the Volta River, etc. A 40-minute film preceded by a 20-minute introduction. Albert R. Mead, University of Arizona, Tucson. Sul Ross Auditorium. *4:00–5:00 p.m.*: Business session and election of officers. Sul Ross Auditorium. *6:00 p.m.*: Open air barbecue, complimenting members of the Southwestern Division and cooperating organizations, Kokernot Lodge. *8:00 p.m.*: Address of R. A. Studhalter, retiring president, Sul Ross Auditorium.

Thursday, May 5, 1949. 8:00 a.m.: All-day field trip to Big Bend Park, including St. Helena canyon. The noon meal will be served at the Park.

NEWS and Notes

Frederick W. Heimberger, Ohio State University faculty member since 1936, has been appointed dean of the College of Arts and Sciences, effective April 15. Dr. Heimberger has served as acting dean since October 1948, when **Dean Harlan H. Hatcher** was made vice president of the University.

Leonard E. Johnston, manager of the Atomic Energy Commission's Knolls Atomic Power Laboratory in Schenectady, New York, has been appointed manager of the AEC's new national nuclear reactor testing station, to be built near Areo, Idaho. Until a successor is appointed at Schenectady, Mr. Johnston will act as manager of both the laboratory and the testing station.

The Howard Crosby Warren Medal has been awarded to **Walter R. Miles,** professor of psychology, Yale University, by the Society for Experimental Psychology, in recognition of his work on night vision during the war.

W. T. Edmondson has resigned as lecturer on biology at Harvard University to accept appointment as assistant professor of zoology at the University of Washington, Seattle, where he will take charge of the program in limnology and ecology.

Alfonso Draghetti, director of the Agriculture Experiment Station at Modena, Italy, has been appointed director of the Experiment Station for Sugar Beet Culture, at Rovigo, Italy. He succeeds Ottavio Munerati.

George R. Herrmann, University of Texas, has been admitted to the Academia Nacional de Medicina of Venezuela.

Sol Pincus, member of the Board of Consultants on Sanitation and Food Problems of the U. S. Public Health Service, has left for Geneva, Switzerland, where he will set up a section on Environmental Sanitation for the World Health Organization.

Lindsay S. Olive, professor of botany, Louisiana State University, has been appointed associate professor of botany at Columbia University, where he will be in charge of graduate instruction in mycology, beginning in September.

Visitors to U. S.

Hasib Kurtpinar, chief of the parasitology section of the Turkish Ministry of Agriculture, has been in this country for more than two years, making a study of recent developments in parasitology. He is now a guest of the Beltsville (Maryland) laboratories of the Bureau of Animal Industry's Zoological Division. Before sailing for Turkey in September, Dr. Kurtpinar expects to visit the Zoological Division's station at Albuquerque, New Mexico, the Bureau of Entomology and Plant Quarantine's station at Kerrville, Texas, and the Veterinary School of Colorado State College.

Gunnar Thorson, of the University of Copenhagen, has joined the staff of the University of California's Scripps Institution of Oceanography as a visiting professor of zoology. He plans to stay in this country three or four months to continue his study of the larvae of marine animals.

Gordon Brims Black McIvor Sutherland, Cambridge University spectroscopist, has been named professor of physics at the University of Michigan.

Grants and Awards

The Columbia University Engineering School Alumni Association will present its 1949 **Egleston Medal** for distinguished engineering achievement to Harvey S. Mudd, president and managing director of Cyprus Mines Corporation. The award will be made April 28 at the Columbia University Club, New York City.

The University of Wisconsin has received a gift of $10,300 from the Thomas E. Brittingham trust fund to initiate an intensive study of arthritis and rheumatism. D. M. Angevine and C. H. Altshuler, Department of Pathology; Harry Bauman, Department of Physical Medicine; and C. V. Seastone, Department of Microbiology, will be in charge of the research.

Cornell University announces the following awards to members of its faculty: to Arthur A. Allen, the **Burr Prize** of the National Geographic Society, for work done in ornithology; and to George Winter, the first **Moisseiff Award** of the American Society of Civil Engineers.

The Rockefeller Foundation has awarded $25,000 to Princeton University for basic research in psychology, to be conducted by Hadley Cantril, Department of Psychology, in collaboration with Adelbert Ames, Jr., Hanover Institute, Hanover, New Hampshire.

Herman L. Kretschmer, president of the Institute of Medicine of Chicago, was recently awarded the **Cross of the Chevalier of the Legion of Honor of France** for his scientific achievements in the field of medicine and medical education.

W. J. Dakin, formerly professor of zoology at the University of Sydney, was chosen **Mueller Medallist** at the 27th conference of the Australian and New Zealand Association for the Advancement of Science, recently held in Tasmania.

The Canadian Council for Reconstruction, through Unesco, has granted $15,000 to the Pasteur Institute in Paris. The agency has also sent scientific equipment worth $60,000 to university laboratories in Belgium, Austria, France, Norway, the Philippines, Greece, and Italy, and has offered free subscriptions to scientific journals to 92 universities.

The American College of Physicians made the following awards at its annual convocation, held in New York City, March 30: **The John Phillips Memorial Award,** to Edwin B. Astwood, research professor of medicine, Tufts College Medical School, for achievement in internal medicine; **The Alfred Stengel Memorial Award,** to James J. Waring,

professor of medicine, University of Colorado School of Medicine, for influence in the advancement of medical education, practice, and research; **The James D. Bruce Memorial Award**, to Stanhope Bayne-Jones, president of the Joint Administration Board of the New York Hospital-Cornell Medical Center, for achievement in preventive medicine. The following doctors were made **Masters of the American College of Physicians** at the same meeting: James J. Waring; Elliott P. Joslin, clinical professor emeritus of medicine, Harvard Medical School; Jonathan C. Meakins, professor emeritus of Medicine, and dean emeritus of the medical faculty, McGill University; and Virgil P. Sydenstricker, professor of medicine, University of Georgia School of Medicine.

Fellowships

Vassar College invites applications for the $1,500 **Helen Gates Putnam Graduate Fellowship in Conservation** for 1949–50. Work may be carried on in any field of plant science related to conservation, and will lead to an M.S. degree in plant science. Applications should be sent to Gladys E. Baker, Chairman, Plant Science Department, Vassar College, Poughkeepsie, New York.

The Arctic Institute of North America is offering a number of grants-in-aid for specific programs of scientific research in the North American Arctic and Subarctic during 1950. Research must include field investigations in Alaska, northern Canada, Labrador, Newfoundland, or Greenland. Application forms may be obtained by writing to The Arctic Institute of North America, 3485 University Street, Montreal, Canada or Audubon Terrace, Broadway and 156th Street, New York City 32. Applications must be in by *November 1*.

The American Cancer Society announces the availability of the **Damon Runyon Clinical Research Fellowships** which it administers upon recommendation of the NRC. Open to men and women with the M.D. degree, the fellowships will, in most cases, provide a period of training in a hospital under the guidance of a qualified clinical investigator but may also be awarded for training in a basic science provided that such training is directed toward preparing the fellow for clinical cancer research. The annual stipend may vary from $2,500 to $6,000; in most instances it will not exceed $4,000. Applications may be submitted at any time and should be addressed to the Executive Secretary, Committee on Growth, National Research Council, 2101 Constitution Avenue, Washington 25, D. C.

Colleges and Universities

The Medical School of the University of Chile, Santiago, which was destroyed by fire last December, appeals to American scientists to send reprints and books on cytology, genetics, and experimental cancer to Dr. Gabriel Gasic, Casilla 2988, Santiago, Chile.

Northwestern University's Medical School has established a radioisotope unit, equipped by a grant from the Atomic Energy Commission through the Office of Naval Research, for instruction, research, and therapy. Howard L. Alt, associate professor of medicine, is chairman of the unit.

Harvard University plans to establish a Laboratory of Human Development for the study of children's behavior. Robert Sears, professor of education and child psychology, has been appointed director and he will be assisted by John W. M. Whiting and Pauline S. Sears. As a preliminary step toward helping schools to understand their pupils, the laboratory will first study the early childhood origins of social motives—the drives to dependency, aggression, and competition that set the patterns of living.

Meetings and Elections

The Cancer Teaching Program of the University of Utah College of Medicine, and the Bureau of Cancer Control of the State Department of Health, will present the **Second Annual Cancer Symposium** April 25–27. Guest speakers will include: George T. Pack, clinical professor of Surgery, New York Medical College; Charles E. McLennan, professor and head of the Department of Obstetrics and Gynecology, Stanford University College of Medicine; Henry S. Kaplan, professor and head of the Department of Radiology, Stanford University College of Medicine; Rulon W. Rawson, chief, Department of Clinical Investigation, Sloan-Kettering Institute of Cancer Research and associate professor of Medicine, Cornell University Medical College; and Howard L. Richardson, assistant professor of Pathology, University of Oregon Medical School.

The West Virginia Academy of Science will hold its 24th annual meeting at Davis and Elkins College, Elkins, West Virginia, April 29–30. Nelle Ammons, of West Virginia University, will give the presidential address, on "The Responsibility of an Academy of Science." Laurence H. Snyder, dean of the Graduate School, University of Oklahoma, will speak on "Heredity and Modern Life."

The American Mathematical Society will hold its 447th meeting at the University of Kansas, in Lawrence, April 29–30. E. J. Mickle, Ohio State University, will speak on "Some Properties of the Lebesgue Area," and R. M. Thrall, University of Michigan, on "Classes of Algebras with Radical." A. S. Householder, Oak Ridge National Laboratory, will address a joint session of the AMS and the **Biometric Society** on "Diffusion of Isotopes in Biological Systems of Several Compartments," John Wishart, of Cambridge University and the University of North Carolina, on "The Elementary Tests of Significance," and J. W. Tukey, Princeton University, on "The Consultant and the Biologist."

The Kentucky Academy of Science will hold its annual meeting at Cumberland Falls State Park, Kentucky, April 29–30. The meeting will include a symposium and field trip on stream life.

The Illinois State Academy of Science will meet May 6–7 at Knox College, Galesburg. The theme of the program is "Science Education." Willard B. Spalding, dean of the College of Education, University

of Illinois, and C. W. Sanford, director of the Illinois Secondary School Curriculum program will speak at general sessions. There will be an education panel discussion in the Psychology and Education Section. R. F. Paton, president of the Academy, will speak at the general session on "Available Energy."

Seventy women engineering students from eastern colleges met recently at Drexel Institute of Technology in Philadelphia to form a **Society of Women Engineers.** Phyllis Evans, a junior at Drexel, was elected president; Margaret Bliss, Tufts, vice president; and Joyce Killian, Alfred University, treasurer.

The Second National Conference of the U. S. National Commission for Unesco was held at Cleveland, Ohio March 31–April 2, following a two-day meeting of the Commission.

Registration was about 3,000 and attendance at the public meeting on the evening of April 1 exceeded 9,000. Although it was designated a national conference, 28 foreign countries were represented. Jaime Torres Bodet, Director General of Unesco, gave one of the principal addresses, and Milton S. Eisenhower, Chairman of the U. S. National Commission, presided at the general sessions. Speakers included Sir John Maud, Permanent Secretary, Ministry of Education, United Kingdom; Sir Ramaswami Mudaliar, Prime Minister of Mysore, India; George V. Allen, Assistant Secretary of State for Public Affairs; and Mrs. Franklin D. Roosevelt, who discussed the development of the Universal Declaration of Human Rights.

Representatives at the conference were from educational organizations ranging from kindergartens to professional schools and learned societies; from general organizations, such as churches, the Farm Bureau, and the Y. M. C. A.; from business organizations, including chambers of commerce, and motion picture, publishing, and broadcasting firms; and from government, principally the Department of State. The conference program provided for such diverse backgrounds by offering simultaneous group and section meetings alternately with the general plenary sessions.

An excellent exhibit of Unesco activities had been prepared and related motion pictures were shown daily. Three 40-page editions of a conference *Journal,* presenting digests of the principal addresses, summaries of group meetings, and general news of the proceedings, gave representatives an opportunity to discuss with others in attendance the events of the conference.

It is difficult to appraise the conference. The diverse interests of the participants and the necessarily intangible character of many of the addresses gave an impression of indefiniteness. Perhaps this was desirable, as well as unavoidable, because many representatives might have lost interest in more specific discussions. However, the general aims and accomplishments of Unesco were well presented, and delegates were given inspiration, to carry back to their own organizations and communities, toward the furtherance of international peace.

DONALD B. PRENTICE

Deaths

Benjamin H. Grave, 71, embryologist for many years, at the Marine Biological Laboratory, Woods Hole, Massachusetts, died January 24, following a fall which fractured his hip.

Max M. Peet, 63, head of the neurosurgery department of the University of Michigan School of Medicine, died March 25 of a heart attack. Dr. Peet was internationally known for his development of an operation for removal of the splanchnic nerves to relieve high blood pressure.

Friedrich Bergius, 64, German chemist who won the 1931 Nobel Prize for developing a process to produce gasoline from coal, died March 30 in Buenos Aires.

William B. Bell, 71, retired chief of the Wildlife Research Division of the Fish and Wildlife Service, in which he served for 28 years, died March 31 at his home in Washington, D. C.

Augustus Daniel Imms, 68, British entomologist, died April 3, at his home near Sidmouth, Devon. Dr. Imms was reader in entomology at Cambridge University from 1931 until his retirement in 1946, and during that period was president of the Royal Entomological Society of London and the Association of Economic Biologists.

A handbook of biological and medical data is being planned by the American Institute of Biological Sciences, with support from the Aero Medical Laboratory, Air Materiel Command, and the School of Aviation Medicine, Randolph Air Force Base. It will present, in the condensed form used by handbooks of chemistry and physics, data from many fields of fundamental and applied biology. The project will be a continuing one, with revised and enlarged editions following the initial volume at regular intervals. All interested biologists are urged to send suggestions on what material should be included and where it can be found to: American Institute of Biological Sciences, 2101 Constitution Avenue, Washington 25, D. C.

The new Aerobiology Department at the Randolph Field School of Aviation Medicine, under the direction of Roland B. Mitchell, is studying the effects of varying environmental factors on infection and immunity. Specifically, the problem is to determine what a given infection, particularly a pulmonary infection, will do to its victim under conditions of rapid change from ground level to extremely high altitude. A preliminary report states that "on experimental pneumococcal, it appeared that animals given a certain dose and then placed at altitudes of 20,000 feet seemed to develop a more rapid and lethal pneumonia than animals given the same dose but maintained at ground level."

Make Plans for—

American Geophysical Union, 24th regional meeting in conjunction with the Western Snow Conference, April 26–27, Denver, Colorado.

Midwestern Psychological Association, April 29–30, Drake Hotel, Chicago.